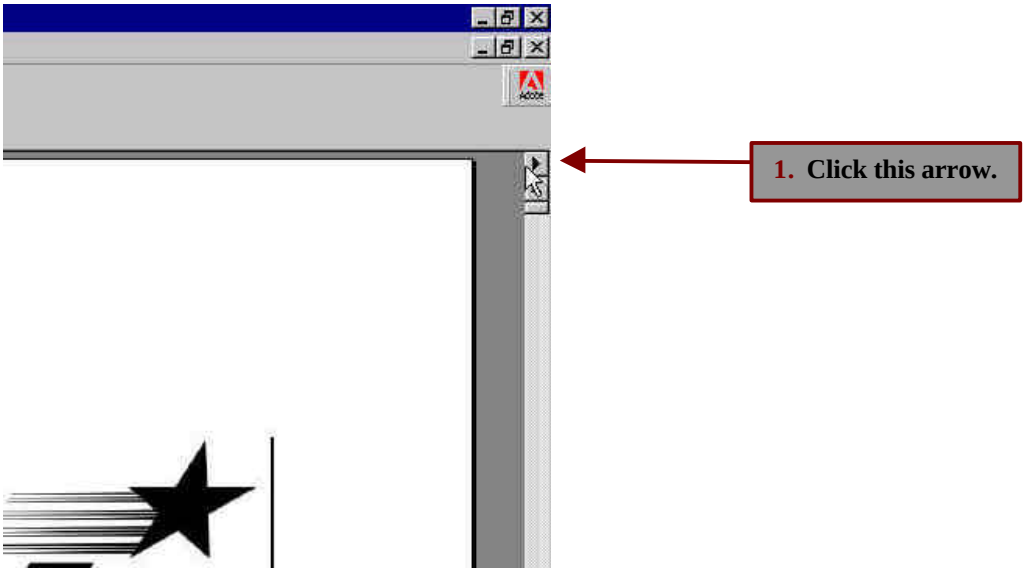
Navigational Notes

Link to download the free Adobe Reader program:

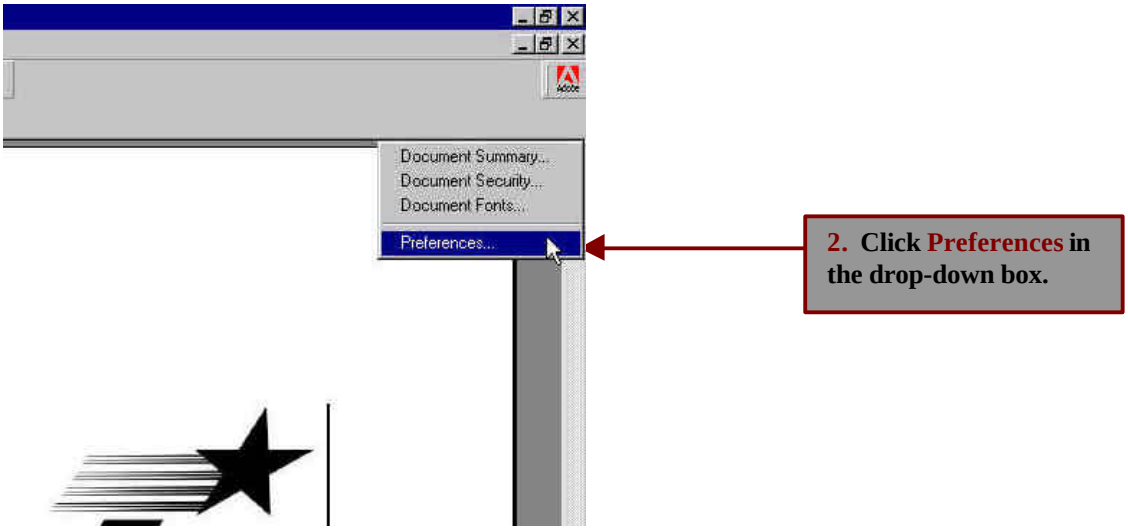
http://www.adobe.com/products/acrobat/readstep2.html

Before attempting to view the accelerated construction PDF document, first double-check to be sure that your display preferences are correctly set to magnify no larger than 75% (the default appears to be 800% when viewing PDF documents with imbedded links).

Step 1 for setting the correct magnification level to 75%:

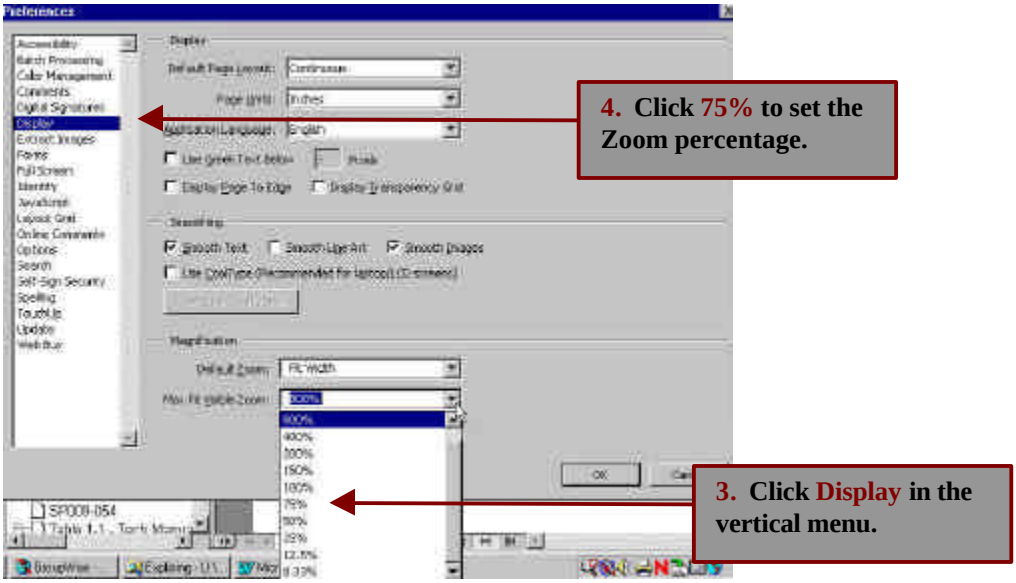


Step 2 for setting magnification level:



Navigational Notes

Step 3 for setting magnification level:



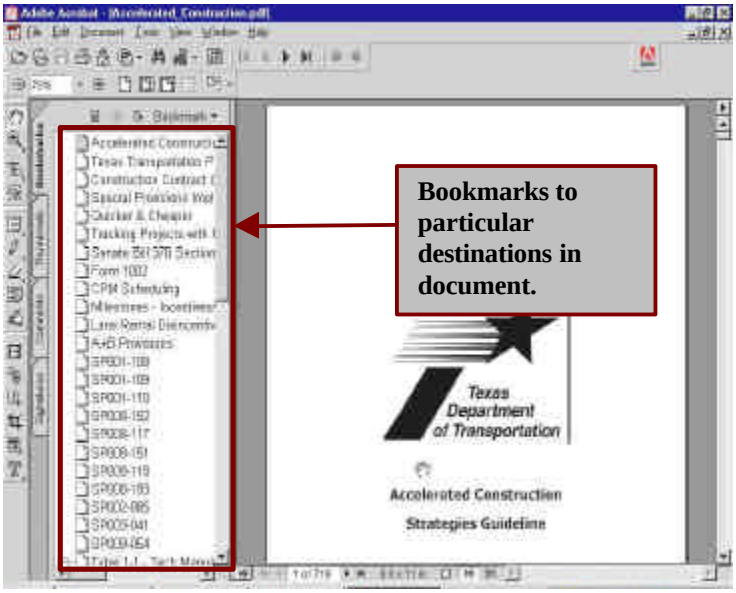
Navigational Notes

Two methods exist for document navigation:

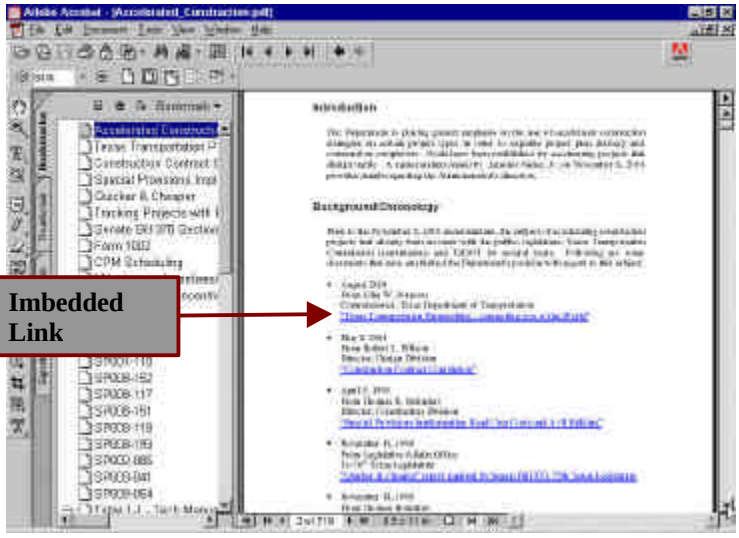
1. **Use the bookmarks listed on the left.**
2. **Use the links provided in the document.**

To utilize the bookmarks, just click on the bookmark to navigate to the beginning of that section of the document (the imbedded blue underlined links will also provide the same navigation.)

Bookmarks are as follows:

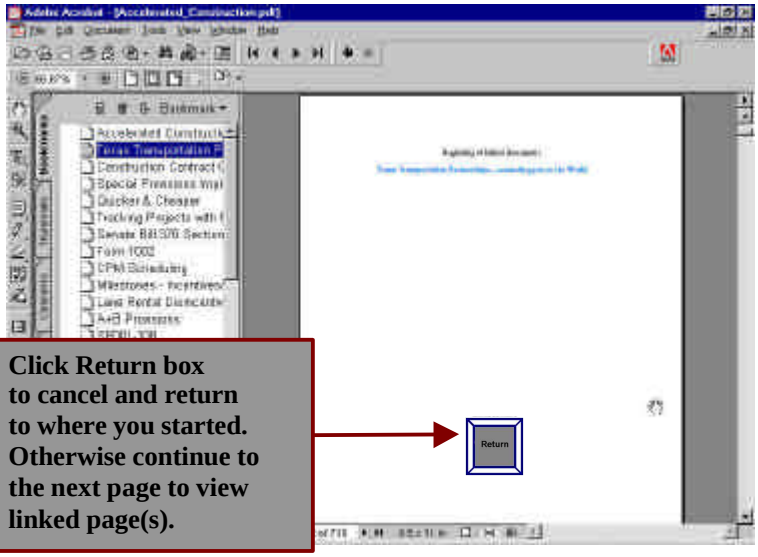


Imbedded links are as follows:

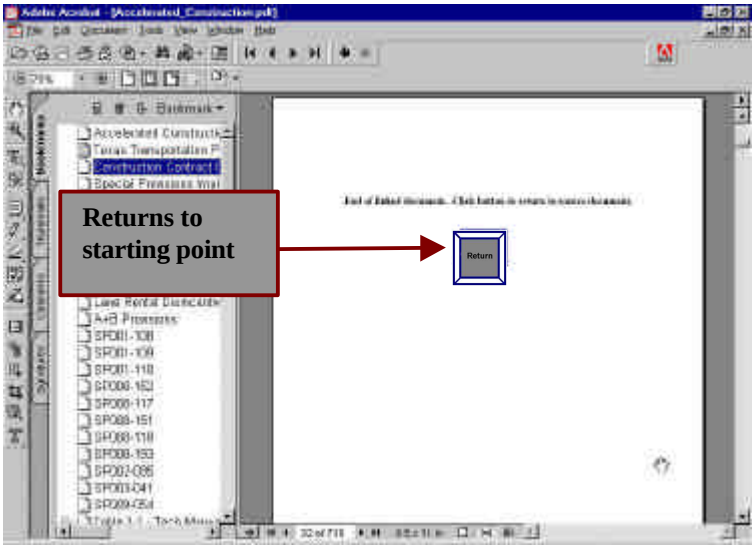


Navigational Notes

A beginning page will precede each link:

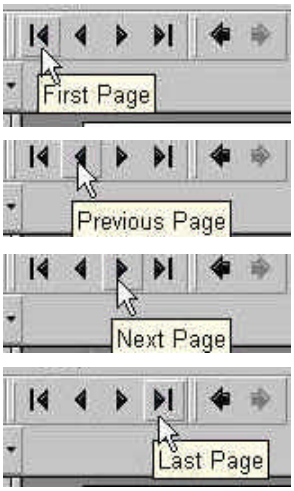


An ending page will follow each link. Click the Return button to go back where you started:

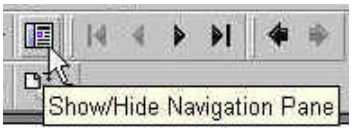


Navigational Notes

Additional navigational tips:



Use the Show/Hide Navigation Pane to view or hide bookmarks panel (hiding the bookmarks panel will provide a larger view of the document):



Helpful Contacts:

Please contact your local help desk for any automation support needs.

Renee Frisinger	**416-2482**	**document details and explanations**
Paul St. Louis	**416-2531**	**document loading and navigation**

Accelerated Construction

Strategies Guideline

September 2003

Introduction

The Department is placing greater emphasis on the use of accelerated construction strategies on certain project types in order to expedite project plan delivery and construction completion. Goals have been established for accelerating projects that disrupt traffic. A memorandum issued by Amadeo Saenz, Jr. on November 8, 2001 provides details regarding the Administration's direction.

Background/Chronology

Prior to the November 8, 2001 memorandum, the subject of accelerating construction projects had already been an issue with the public, legislature, Texas Transportation Commission (commission) and TxDOT for several years. Following are some documents that have established the Department's position with regard to this subject:

- August 2001
  From John W. Johnson
  Commissioner, Texas Department of Transportation
  "Texas Transportation Partnerships…connecting you to the World"

- May 8, 2001
  From Robert L. Wilson
  Director, Design Division
  "Construction Contract Completion"

- April 5, 1999
  From Thomas R. Bohuslav
  Director, Construction Division
  "Special Provisions Implementing Road User Costs and A+B Bidding"

- November 19, 1998
  From Legislative Affairs Office
  To 76th Texas Legislature
  "Quicker & Cheaper" report required by Senate Bill 370, 75th Texas Legislature

- November 18, 1998
  From Thomas Bohuslav
  Director, Construction Division
  "Tracking Projects with Road User Costs"

- July 14, 1998
  From Charles W. Heald
  Executive Director
  "Senate Bill 370 Section 223.012 – Travel Delay Costs (Road User Costs)"

As you can tell from the previous correspondence, a considerable amount of information and guidance has already been provided. This site will serve as a resource for the districts and others with information regarding:

Administrative Direction

The goal of the Administration is to reduce the time it takes to complete a project, from conception through the end of construction. Time requirements for accelerated construction should be considered for areas that have a significant impact to businesses and traffic flow. Utilities and other conflicts will be encountered during construction; however, across-the-board exceptions for using acceleration provisions will not be given for these expected conflicts. Coordination of utility and other third party work should occur early on during the planning and design stages. Strategies for acceleration also need to be discussed during the Design Concept Conference.

Department Goals

Under the heading, "Streamlined Project Delivery" in Commissioner Johnson's report (page 12), the goal of improving project delivery from project conception to ribbon cutting, on average, should be reduced by 15 percent within 5 years. In order to achieve the acceleration goal presented in Commissioner Johnson's report, designers must perform a thorough analysis of the time needed for construction and use contracting strategies that emphasize timely completion. Acceleration provisions will be required on all projects that disrupt traffic.

Form 1002, Page 4

With the recent requirement to accelerate various types of construction projects, Form 1002, page 4 was revised accordingly and must be completed for each contract submitted. The revised form will identify the project type and the strategy selected to accelerate it. DES also extracts information from the form for inputting into the project tracking system. Monthly reports are generated and provided to the Administration in order that they are kept informed.

Should a qualifying contract not include accelerating provisions, an exception must be requested and submitted to the Design Division prior to PS&E submission. Each request must include usual and appropriate project information and a detailed explanation of the reason(s) for not accelerating completion. Early submission of an exception request will ensure sufficient time is provided for review, discussion and approval to not delay the project's letting. Form 1002 is available on-line by accessing DES's crossroads web site. For assistance, please contact your respective DES Field Area representative.

Design Considerations

The following issues must be addressed during PS&E project development:

- Make sure ROW is acquired and utilities are adjusted before construction. If not, make sure sequence of work allows working around conflicts and the time determination schedule includes any outstanding ROW acquisitions and utility adjustments.
- Make sure all environmental issues (permits, restrictions, and commitments) are considered in PS&E and all needed permits are acquired.
- Start out with a complete set of plans and specifications. Accurately estimate quantities of work.
- Start out with a realistic time determination schedule, and allow an adequate number of working days.
- Consider the effects of weather on the allowed time.
- Minimum temperature restrictions may prevent some work to be done at night, especially during the winter. For example, polymer nosing materials for bridge header joints (Special Specification 4454) cannot be done unless the temperature is 45 degrees and rising.
- Consider long lead-time items (traffic signals, overhead and cantilever sign bridges) in the time allowed to complete the work. Use 60, 90 or 120 day delayed start provision for materials procurement.
- Let at appropriate time of year. It does no good to let a seal coat project in fall if work cannot start until the next spring.
- Third parties (cities, counties, and utility companies) may have funding limitations that may affect the pace of work.
- If the project includes vegetative establishment, be advised that seeding can only take place during the appropriate season. Make sure the time determination schedule considers this.
- Make sure PS&E undergoes complete constructability review before letting.
- Consider the effects of traffic on material delivery and available construction times.

If several of these issues are unresolved when PS&E is complete, do not choose a highly aggressive contract acceleration strategy (A+B bidding or lane rental are examples). Instead, choose the least aggressive strategy possible (five working day calendar, for example).

Construction Considerations

During construction, the demand for inspection will be increased. Look into supplementing inspection forces with rent-a-tech contract inspectors. Projects must be staffed with personnel who can:

- Review, monitor and analyze CPM schedules

- Work with the Contractor to solve problems proactively
- Process change orders timely
- Make timely contract administration decisions
- Take suggestions from the Contractor to resequence the project and accelerate the work.
- Work with the Contractor to revise the schedule to show the effect of resequencing on the overall project duration – it may be discovered that the proposed acceleration doesn't really help the project finish any earlier.

Material availability may be an issue for accelerated projects. Small quantities of concrete, for example, are difficult to schedule. Large quantities of concrete for a bridge deck are easier to procure because the supplier knows there is money to be earned.

Accelerated construction will greatly affect the ability of the Contractor to use subcontractors, especially DBE/HUB subcontractors. Be advised that work added to one project, especially work performed by DBE/HUB subcontractors, may ripple over and delay other projects.

Strategies for Accelerated Construction

The following is a listing of individual strategies for construction acceleration that can be used alone or in combination. Links are provided for additional information regarding Milestones, Lane Rental, and A+B Bidding. Additional information is also available regarding CPM Scheduling.

Calendar Day (CD) Definition for Working Day - Use alone with standard contract administrative liquidated damages (CALD) with time calculated to the final acceptance date. A five-day per week definition for working day is recommended for most applications. Calendar day definition for working day is required with all acceleration strategies.

Incentive Using Contract Administrative Cost or Daily Road User Cost (RUC) - Pay for early completion at the standard CALD rate or daily RUC. Use calendar day definition and calculate days to the final acceptance date. Set a maximum allowable bonus payment. Include a no excuse bonus provision for incentives. A "no excuse bonus" provision disallows time adjustments for the bonus time requirement when factors outside the contractor's control delay completion.

Milestones with Incentives/Disincentives (I/D) - Identify specific project phases that have a significant impact on traffic or businesses. Include I/D for those phases only. Base the I/D on road user cost (RUC). Increased disincentives may be used alone, without incentives. Use CD definition for working day. Time is based on substantial completion of the phase. Set a maximum allowable bonus payment. Include a no excuse bonus provision for incentives.

Substantial Completion I/D - Use I/D for early completion of the project. Calculate time to the substantial completion date. Use calendar day definition for working day and set a maximum bonus for early completion. Base the I/D on RUC. Increased disincentive may be used alone, without incentives. Include a no excuse bonus provision for the incentive.

Lane Rental Disincentive - Use for pavement maintenance work and managing intermittent lane closures to minimize impact to traffic for construction projects. Base the disincentive on RUC. Consider varying RUC values for daytime and nighttime work.

A+B Provisions - Consider for large and or highly critical projects where early completion should be a consideration for award. Include I/D for milestones or final substantial completion. Use calendar day definitions for working day. Set a maximum allowable bonus payment.

Specification Requirements

The following is a listing of each strategy for construction acceleration with the applicable required special Provisions:

- **Calendar Day Definition for Working Day**

  Calendar Day Definition can be used alone with standard contract administrative liquidated damages with time calculated to the final acceptance date. The following statewide special provisions to Item 1, "Definition of Terms" can be used for projects with Calendar Day Definition:

  SP001-108 - Defines the working day as ***5 calendar days*** per week and adds the daily road-user definition.
  SP001-109 - Defines the working day as ***6 calendar days*** per week and adds the daily road-user definition.
  SP001-110 - Defines the working day as ***7 calendar days*** per week and adds the daily road-user definition.
  SP001-202 – Defines the working day as ***7 calendar days*** per week excluding up to two "floating" non-work days per calendar month.
  SP001-203 – Defines the working day as ***7 calendar days*** per week excluding up to three "floating" non-work days per calendar month.

  A five-day per week definition for working day is recommended for most applications.

- **Incentive Using Contract Administrative Cost**

This strategy will allow an incentive payment to be made to the contractor for early completion at the standard Contract Administrative Liquidated Damages rate. Set a maximum allowable bonus payment. Include a no excuse bonus provision for incentives.

- Use **SP001-108**, **SP001-109**, **SP001-110**, **SP001-202**, or **SP001-203**
- Use SP008-152, "Prosecution and Progress". Credit for completing the project ahead of time using daily CALD.
- Use SP008-248, "Prosecution and Progress". Credit for completing the project ahead of time using standard CALD, or similar (***incentive provision***).
- When incentive involves daily RUC, use SP008-117, "Prosecution and Progress". Provides for a basic Critical Path Method (CPM) Project schedule (basic CPM Project schedule is not required when standard CALD incentives are used).

- **Milestones with Incentive/Disincentives (I/D)**

When using this strategy, identify specific project phases that have a significant impact on traffic or businesses. Include I/D for those phases only. Base I/D on road user cost. Increased disincentive can be used alone, without incentives. Include a no excuse bonus provision for incentive.

- Use **SP001-108**, **SP001-109**, **SP001-110**, **SP001-202**, or **SP001-203**
- Use SP008-151, "Prosecution and Progress". Failure to substantially complete the project (or specified phases of the project) within the established number of working days stated in the contract, plus any additional working days granted, will result in the daily road-user cost being assessed. Also, contract administration liquidated damages will be assessed for failure to complete the entire project within the established number of working days stated in the contract, plus any additional working days granted.
- Use **SP008-152**, "Prosecution and Progress". Credit for substantially complete the project and/or phases ahead of time (***incentive provision***). Use SP001-152 when incentive provisions are desired.
- Use SP008-118, Prosecution and Progress". Requires Contractor to use a Critical Path Method (CPM) Project Schedule using the Precedence Diagram Method (PDM). Advanced CPM.

- **Substantial Completion Incentive/Disincentives (I/D)**

Use I/D for early completion of the project. Calculate time to the substantial completion date. Set a maximum bonus for early completion. Base the I/D on road user cost and include a no excuse bonus provision for the incentive.

- Use **SP001-108, SP001-109, SP001-110, SP001-202**, or **SP001-203**.

- Use **SP008-151**, "Prosecution and Progress". Failure to substantially complete the project (or specified phases of the project) within the established number of working days stated in the contract, plus any additional working days granted, will result in the daily road-user cost being assessed. Also, contract administration liquidated damages will be assessed for failure to complete the entire project within the established number of working days stated in the contract, plus any additional working days granted.
- Use **SP008-152**, "Prosecution and Progress". Credit for substantially complete the project and/or phases ahead of time (***incentive provision***). Use SP001-152 when incentive provisions are desired. Upon final completion, pay for each day of early completion at the CALD rate.
- Use **SP008-118**, Prosecution and Progress". Requires Contractor to use a Critical Path Method (CPM) Project Schedule using the Precedence Diagram Method (PDM). Advanced CPM.

▪ **Lane Rental Disincentive**

Use this strategy for pavement maintenance work and managing intermittent lane closures to minimize impact to traffic during construction. Disincentive should be based on road user cost. Consider varying road user cost values for daytime and nighttime work.

- Use **SP001-108** or **SP001-109** or **SP001-110**.
- Create a Special Provision to Item 8, "Prosecution and Progress", similar to **SP008-151**, defining substantial completion when all project work (or the work for a specified milestone of the project) requiring lane or shoulder closures. The Milestones, daily road user cost, number of lanes closed and duration in days should be shown in a table format. In addition, number of lanes closed, hourly rentals for peak hours, weekday, weekend and nighttime should be listed.
- For reference, see ***special provision*** *008---193* (one-time use).

▪ **A+B Provisions**

This strategy can be considered for large and or highly critical projects where early completion should be a consideration for award. Include I/D for milestones or final substantial completion. Set a maximum allowable bonus payment.

- Use **SP001-108** or **SP001-109** or **SP001-110**.
- Use SP002-085, "Instruction to Bidders". Require the bidder to submit the number of working days to substantially complete the project or phases of the project.
- Use SP003-041, "Award and Execution of Contract". Redefines how the bids are considered to include A + B bidding.
- Use **SP008-151**, "Prosecution and Progress". Failure to substantially complete the project (or specified phases of the project) within the established

number of working days stated in the contract, plus any additional working days granted, will result in the daily road-user cost being assessed. Also, contract administration liquidated damages will be assessed for failure to complete the entire project within the established number of working days stated in the contract, plus any additional working days granted.

- Use **SP008-152**, “Prosecution and Progress”. Credit for substantially complete the project and/or phases ahead of time (***incentive provision***). Use SP001-152 when incentive provisions are desired.
- Use **SP008-118**, Prosecution and Progress”. Requires Contractor to use a Critical Path Method (CPM) Project Schedule using the Precedence Diagram Method (PDM). Advanced CPM.
- Use SP009-054, “Measurement and Payment”. Defines how daily values for road-user cost and contract administration liquidated damages will be used and by the omission of days bid in this article.

Road User Costs

"Road user costs" (RUC) is defined as the estimated daily cost to the traveling public resulting from the construction work being performed. That cost primarily refers to lost time caused by any number of conditions including:

- detours and rerouting that add travel time
- reduced roadway capacity that slows travel speed and increases travel time; and
- delay in the opening of a new or improved facility that prevents users from gaining travel time benefits.

Guidelines and procedures have previously been developed for TxDOT by TTI which detail how to determine the best suited technique for calculating road user costs. Table 1-1 of "Techniques For Manually Estimating Road User Costs Associated With Construction Projects" categorizes candidate projects and presents a simplified guide for determining the best technique to use.

Another document developed by TTI, "A Short Course on Techniques for Determining Construction Related Road User Costs", was used as a two day training course to provide TxDOT staff with the expertise to complete road user cost studies for roadway construction projects. This course briefly presents a process to select the proper techniques to complete a road user cost study, the proper way to use either manual methodologies or computer simulation tools to determine user delays, and how to convert the user delays into a monetary value.

By becoming familiar with the above two documents, district and division staff should be able to quickly determine the most appropriate technique for calculating road user costs on any project or phase.

Links are also available for RUC calculations related to added capacity, a rehabilitation project, and an example for IH-410 in San Antonio (From Callaghan Road to Fredericksburg Road).

Determining Accelerated Construction Strategy

If a project meets any of the criteria requiring accelerated construction strategies, the district must determine the most appropriate method to be used. Of course, the simplest thing to do would be to just insert the calendar day definition, but that probably would not be enough to attain the Department's goals. Identifying an appropriate strategy early in project development is highly recommended. For this reason, the DSR has been updated to include a section outlining the various available strategies.

Identifying a suitable strategy early, the responsible party performing calculations or the need for an exception will benefit all parties involved in a project's development and ensure timely development. In some cases, the district may want to consult with the division offices (TRF, CST and DES) for direction as to how to proceed. If a strategy is chosen that will require determining road user costs, this can be handled based upon project complexity and experience of district staff. District staff may perform the calculations or seek assistance from the divisions. Until both district and division staff become more experienced with performing calculations involving computer simulation models, there are other options available to the districts. If the project is being designed by a consultant contract, provisions could be added to the agreement for the consultant to calculate road user costs as needed. Another option would be for the district to set up one or more evergreen contracts to handle these project specific calculations. TxDOT currently has an interagency agreement with TTI and TTI has provided assistance on a limited basis in providing training and performing RUC calculations.

Division Contacts and Other Links

DES Field Area Representatives		
Field Area I	George Gold (512) 416-2706	Maria Burke (512) 416-2703
Field Area II	Ray Thomasian (512) 416-2718	Elizabeth Hilton (512) 416-2689
Field Area III	Robert Stone (512) 416-2670	Doug Woodall (512) 416-2673
CST Contacts		
Elizabeth S. Boswell, P. E.	CST, RA 200, 2nd Floor	(512) 416-2456
TRF Contacts		
Charles Koonce	TRF RA 118	(512) 416-2434
Meg Moore	TRF RA 118	(512) 416-3132
TTI Contacts		
Ginger Daniels Goodin	Austin Office	(512) 467-0946
Carol Walters	Arlington Office	(817) 277-5503
Darrell Borchardt	Houston Office	(713) 686-2971
Russell Henk	San Antonio Office	(210) 731-9938

Beginning of linked document:

Construction Contract Completion

MEMORANDUM

TO: All District Engineers May 8, 2001

FROM: Robert L. Wilson

SUBJECT: Construction Contract Completion

We have been asked by the Administration to identify any projects that might have a potential to use accelerated construction contract provisions and report those to the Administration each month. We have currently identified seven (7) general project types, as outlined on the attached sheet, as having the potential for including those provisions.

The techniques to encourage accelerated construction completion can include: calendar day definition, increased liquidated damages (road user costs/disincentive), incentive, lane rental cost, A + B bidding or combinations of these applied to the overall project and/or milestone completion of phases of a project. Please reference Mr. Charles W. Heald's memo dated July 14, 1998 for further details in how to use these techniques. Attached are some of the guidelines in using alternative contract strategies.

In order for us to provide meaningful information to the Administration, we will need you to fill out the attached form and transmit it as an attachment to Form 1002 with each P.S.&E.

We appreciate your cooperation in this effort.

cc: Michael Behrens
TRF, BRG, CST, ROW, ENV, TPP

ALTERNATIVE CONTRACTING PROCEDURES

Attachment A to Form 1002

District		County	
Control		Project No.	
Highway		Limits	

The following types of projects are good candidates for the use of accelerated construction contract provisions. Check all that apply to this project:

- ❑ Interstate or freeway project with lane closures during one or more phases of construction
- ❑ Bridge closure (either as the entire project or a portion of a larger project)
- ❑ Road closure
- ❑ Added Capacity projects
- ❑ Non-freeway with ADT>10,000 and lane closures during one or more phases of construction
- ❑ Provides access to a nearby school, emergency services (hospital, fire, etc.), or major traffic generator
- ❑ Project affects access to adjacent businesses
- ❑ None of the above (disregard remainder of this page)

If any of the above criteria apply, are accelerated contract provisions (calendar days, Increased liquidated damages, incentive/disincentive, A+B, lane rental) included on this project?

☐ Yes ☐ No

If not, explain why accelerated contract provisions were not utilized:

_____

_____

_____

_____

_____

Alternative Contract Strategies being used by TxDOT

1. **Liquidated Damages**
   a) **Contract Administration:** The estimated daily cost for TxDOT to administer the contract.
   b) **Daily Road User Cost:** The estimated daily cost of inconvenience to the traveling public resulting from the roadway construction or from the lack of access to the completed facility. Inconvenience is defined in terms of lost time. The current value being used is $16.24 per vehicle per hour.

2. **A&B Bidding:** A+B Bidding is a Cost-Plus-Time bidding procedure. The low bidder is selected based on a combination of the contract bid items (A) and the time bid for construction multiplied times the daily road user cost (B). The days bid becomes the contract time.

3. **Incentive/Disincentive:** The daily road user cost can be incorporated into the contract as liquidated damages (disincentive) and as an incentive. When used as an incentive the contractor receives the daily road user cost for each day they substantially complete the project or a specific phase of the project early. A maximum number of days of incentive that can be earned is specified in the contract.

4. **No Excuse Bonus:** This is a modified version of the incentive. The contractor receives the daily road user cost for each day they substantially complete the project or specified phase of the project early, however, no adjustments to the specified time is allowed for any reason regardless of who is responsible. Thus the contractor is motivated to work around conflicts such as utilities.

5. **Lane Rental:** Contracting strategy used to improve management of temporary lane closures. The contractor is assessed an hourly rental fee for each lane, or combination of lanes taken out-of-service during a project to minimize the time that of the roadway restriction impacting traffic flow. The rental fee is based on hourly road user costs.

6. **Calendar Day:** The contract specifies the number of days for completion of the project. TxDOT has traditionally not charged a day against the contract when weather would not permit work. When a calendar day definition is set up in the contract, TxDOT charges a day regardless of the weather, thus the risk of weather is transferred to the contractor.

Alternative Contracting Strategies GUIDELINES

Reference Mr. Charles W. Heald, P.E. July 14, 1998 memorandum

PROJECT SELECTION GUIDELINES

PRIMARY CRITERIA: TYPES OF PROJECTS

- Projects that add capacity (may include grade separations).
- Projects where construction activities are expected to have an economic impact to local communities and businesses.
- Rehabilitation projects in very high traffic volume areas.

SECONDARY CRITERA:

- Conflicting utilities will be relocated prior to construction and the right-of-way is clear.
- There is an adequate inspection force available.
- 25% of the estimated road user cost is greater than the contract administrative liquidated damages.

If any of the secondary criteria is not met, the district should reevaluate the proposed use of road user cost liquidated damages before making the decision.

INCENTIVES: When the decision has been made to use road user cost, districts should include incentives with the disincentive. There may be occasion when the potential for discovery of unknown utilities during construction make it prudent to include road user cost as disincentives only. When including incentives, a maximum bonus (number of days) shall be included in the project proposal.

DAILY ROAD-USER COST VALUE: Only 25% of the calculated road user cost should be used for the rates shown in the plans. The daily rate for road user cost may only be applied to the point of completed (end phase) stated in the plans for each phase or substantial completion for the total project. Substantial completion is defined as occurring when all project work requiring lane or shoulder closure or obstructions is completed, and traffic is following the lane arrangement as shown on the plans for the finished roadway, or phase.

DEFINITION OF A WORKING DAY: Calendar definitions should also be used for all A+B and incentive projects and may be used on road user cost projects without incentives.

TABLE OF ROAD USER COST GUIDELINES

Suggested Road user Requirements	Type of Projects
A + B Bidding Strategy	May be used on projects with high volumes that have a significant impact on the local business or create road-user cost in excess of $40,000.00. A+B bidding should be used on a very limited basis. (CPM required)
Road User Cost with Incentive	The majority of projects with higher liquidated damages that meet the criteria in Mr. Wes Heald's guidance memo of 7/14/98 should use incentives. (CPM required)
Road user Cost without Incentive	May want to use road-user cost without incentives on projects where the risk of having utility conflicts is high, such as projects in older urban areas.
Contract Administration Liquidated Damages Only	Majority of TxDOT projects.

Contract Information Required for Road User Cost:

1. Working day definition.
2. Address work hours allowed (i.e. nighttime).
3. Cost per day for each phase and/or substantial completion.
4. Beginning of phases (if applicable).
5. Ending of phases (if applicable).
6. Maximum Bonus (number of days ahead of schedule) (incentive only).
7. Minimum days bid (A + B only).
8. *The time between substantial completion and project acceptance or the total time.*

A GUIDE TO CONTRACTING STRATEGIES & CONTRACT PROVISIONS

	CONTRACT PROVISIONS										
CONTRACTING STRATEGY	1a,b, or c	2	3	8a	8b	8c	8d	8e	8f	9	GN's
Std Low Bid w/Bar Chart.						✓					
Std Low Bid w/Basic CPM.						✓					1
Std Low Bid w/Advanced CPM.							✓				
Std Low Bid w/Road user Cost Damage Only.	✓			✓			✓				2,3
Std Low Bid w/Road user Cost Damage & Incentive.	✓			✓	✓		✓				2,3,4
A+B Bid w/Road User Cost Damage Only.	✓	✓	✓	✓			✓			✓	2,3,5,6
A+B Bid w/Road User Cost Damage & Incentive.	✓	✓	✓	✓	✓		✓			✓	2,3,4,5,6
No Excuse Bonus								✓			2,3,4
Lane Rental									✓		

KEY TO GENERAL NOTES

1. General note requiring basic CPM.
2. General note required for specifying project specific daily road user cost value(s).
3. General note for establishing the beginning and ending of phases.
4. General note required for specifying project specific maximum number of days for incentive(s).
5. General note required for specifying project specific maximum number of days that can be bid.
6. General note required for establishing time between substantial completion and project acceptance (to be used when total time is not established by TxDOT).

CONTRACT PROJVISIONS (1993 Specifications Book)

1a. SP 001-108: Definition of Terms – daily road user cost and 5 days/week calendar day definitions.

1b. SP 001-109: Definition of Terms – daily road user cost and 6 days/week calendar day definitions.

1c. SP 001-110: Definition of Terms – daily road user cost and 7 days/week calendar day definitions.

2. SP 002-085: Instruction to Bidders – to submit working days.

3. SP 003-041: Award and Execution of Contract – consideration of bids being A+B.

8a. SP 008-151: Prosecution and Progress – Road User and Contract Administration Cost Liquidated Damages.

8b. SP 008-152: Prosecution and Progress – Incentive Provision.

8c. SP 008-117: Prosecution and Progress – bar chart or basic CPM schedules required to be submitted by contractor.

8d. SP 008-118: Prosecution and Progress – Advance CPM.

8e. SP 008-xxx: Prosecution and Progress – No excuse bonus incentive provision.

8f. SP 008-xxx: Prosecution and Progress – General lane rental provision. Addendum to special provision required with lane rental schedule.

9. SP 009-054: Measurement and Payment – Explains that the days bid are for comparison purposes only and not a pay item.

ADDITIONAL GUIDANCE ON A+B BIDDING

1. When doing A+B bidding, the district has the option of setting the time between substantial completion and project acceptance (or the time suspension for end of project establishment, maintenance or performance periods) by general note, or setting the total time for the project regardless of the time bid by the contractor.

If TxDOT establishes the total time, then that number of days will be placed on the cover sheet as shown below.

> *"It is further understood that the work is to be completed in full in _210_ working days."*

When the time between substantial completion and project acceptance is specified by general note then an asterisk will be placed in the blank and a note will appear at the bottom of the cover sheet as shown below.

> *"It is further understood that the work is to be completed in full in __*__ working days."*
>
> *"*When the working days field contains an asterisk refer to the general notes or special provisions."*

Refer to general note number 6. The Design Division will have further instructions regarding placing the asterisk in the blank space.

2. An 800 item should be added for the contractor to be able to bid the number of days to substantially complete the project, or multiply items should be added for bidding the number of days to complete phases of the project. Please note that in A+B the contractor will bid the days to substantial completion, and will not bid the total time. The reason for bidding the days to substantial completion is because the daily road-user cost values are based on substantial completion. As indicated above, the district has the option of setting the number of days the contractor has to obtain final acceptance after substantial completion by using a general note or the district may specify the total time on the cover sheet. Refer to general note number 6.

Add Item 800-XXX to proposal sheet as follows:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT BID PRICE
800-0505	Road-User Cost	$/DA	$XX,XXX	No. of days bid
or for bidding multiple phases as follows:				
800-050_	Road-User Cost Phase 1	$/DA	$XX,XXX	No. of days bid
800-050_	Road-User Cost Phase 2	$/DA	$XX,XXX	No. of days bid
800-050_	Road-User Cost Phase 3	$/DA	$XX,XXX	No. of days bid

Note that there is not an Item 800 specification or special provision. Additional guidance will be forthcoming regarding the tracking of incentive credits and road-user cost liquidated damage charges.

CONTRACTING STRATEGIES:
CONTRACT PROVISIONS

Special Provision Numbers are referenced to the 1993 Specifications Book (Blue). The numbers on the left correspond with the ***Guide to Contracting Strategies & Contract Provisions.***

1a. SP 001-108: Definition of Terms – daily road user cost and 5 days/week calendar day definitions.

1b. SP 001-109: Definition of Terms – daily road user cost and 6 days/week calendar day definitions.

1c. SP 001-110: Definition of Terms – daily road user cost and 7 days/week calendar day definitions.

2. SP 002-085: Instruction to Bidders – to submit working days.

3. SP 003-041: Award and Execution of Contract – consideration of bids being A+B.

8a. SP 008-151: Prosecution and Progress – Road User and Contract Administration Cost Liquidated Damages.

8b. SP 008-152: Prosecution and Progress – Incentive Provision.

8c. SP 008-117: Prosecution and Progress – bar chart or basic CPM schedules required to be submitted by contractor.

8d. SP 008-118: Prosecution and Progress – CPM schedules prepared using Suretrak or Primavera required to be submitted on computer diskettes.

9. SP 009-054 (040): Measurement and Payment – Explains that the days bid are for comparison purposes only and not a pay item.

CONTRACTING STRATEGIES:
EXAMPLE GENERAL NOTES

The general note numbers correspond with the ***Guide to Contracting Strategies & Contract Provisions.***

1. General note requiring basic CPM.

---ITEM 8.2---
The schedules will be required to be submitted in a CPM format.

2. General note required for specifying project specific daily road-user cost value(s).

WITHOUT MILESTONES
---ITEM 8.6---
The road-user cost liquidated damages shall be $ _____ per day.

WITH MILESTONES
Note that when setting up milestones on a project it is usually necessary to provide a detailed description of the work considered to be included in each milestone or phase. This may be done in a sequence of work special provision, the traffic control plans, or by general notes. The description should be clear, easily identified, and based on the shifting of traffic in the particular phases. It is especially important in establishing the beginning and ending of phases to base them on the shifting of traffic and not on general work areas. In our opinion, the contractor should be permitted to perform work on any phase provided such work is not detrimental to the scheduled phase in progress and does not conflict or affect the approved traffic control plans.

---ITEM 8.6---
The road-user cost liquidated damages for Phase 1 (Milestone 1) shall be $ _____ per day.
The road-user cost liquidated damages for Phase 2 (Milestone 2) shall be $ _____ per day.

The contractor shall have _____ working days to substantially complete Phase 1 (Milestone 1).
The contractor shall have _____ working days to substantially complete Phase 2 (Milestone 2).

Repeat as necessary.

3. General note for establishing the beginning and ending of phases.

Examples for establishing the beginning of phases:
---Item 8.5---
The time charges for the substantial completion of the project shall begin when time charges begin for the project.

The time charges for Phase _____ shall begin when traffic is moved to the lane arrangement shown in the traffic control plans for the phase.

The time charges for Phase _____ shall begin upon completion of the previous phase.

The beginning date of each milestone will be the date following completion of the previous milestone.

Examples for establishing the ending of phases:

---Item 8.5---

The time charges for Phase _____ shall end when traffic is moved to the lane arrangement shown in the traffic control plans for the succeeding phase.

The time charges for Phase _____ shall end upon the beginning of the succeeding phase.

The ending date of each milestone will be the date preceding the beginning of the succeeding milestone.

4. **General note required for specifying project specific maximum number of days for incentive(s).**

---ITEM 8.11---
The maximum number of working days for computing the incentive credit shall be _____ days.

5. **General note required for specifying project specific minimum number of days that can be bid when doing A+B bidding.**

---ITEM 2.5---
The minimum days that can be bid for the substantial completion of Phase 1 is _____.
The minimum days that can be bid for the substantial completion of Phase 2 is _____.
The minimum days that can be bid for the substantial completion for the project is _____.

6. **General note required for establishing time between substantial completion and project acceptance (to be used when total time is not established by TxDOT).**

The number of working days for final acceptance will be 60 working days after the substantial completion of the project.

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Beginning of linked document:

Special Provisions Implementing Road User Costs and A+B Bidding

MEMORANDUM

TO: District Engineers **Date:** April 5, 1999

FROM: Thomas R. Bohuslav, P.E., CST

SUBJECT: Special Provisions Implementing Road User Costs And A+B Bidding

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Please find attached the following information concerning the referenced:

1. A guide to Contracting Strategies & Contract Provisions
2. Contracting Strategies: Road-User Cost and A+B Bidding Guidelines
3. Additional Guidance on A+B Bidding
4. A+B Bidding: RUC Credit/Damage Scenarios with Incentive
5. Contracting Strategies: Example General Notes
6. Contracting Strategies: Contract Provisions

The contract provisions for setting up road user costs or A+B bidding have been approved for statewide use. The special provision numbers are shown on the Guide to Contracting Strategies & Contract Provisions.

Included in the provisions are 5, 6, and 7 day calendar day special provisions with the definition of daily road user costs added. We have made changes to calendar day definitions to eliminate a conflict that was causing disputes. We encourage you to use these provisions in lieu of previous calendar day special provisions even when you do not include road user costs in your contract.

If you have any questions, you may call the Design Division or Mr. Bob Hundley, P.E. with the Construction Section.

Attachments

Cc: Mike Behrens, P.E., AEDEO
Robert Wilson, P.E., DES

A GUIDE TO CONTRACTING STRATEGIES & CONTRACT PROVISIONS

	CONTRACT PROVISIONS										
CONTRACTING STRATEGY	1a,b, or c	2	3	8a	8b	8c	8d	8e	8f	9	GN's
Std Low Bid w/Bar Chart.						✓					
Std Low Bid w/Basic CPM.						✓					1
Std Low Bid w/Advanced CPM.							✓				
Std Low Bid w/Road user Cost Damage Only.	✓			✓			✓				2,3
Std Low Bid w/Road user Cost Damage & Incentive.	✓			✓	✓		✓				2,3,4
A+B Bid w/Road User Cost Damage Only.	✓	✓	✓	✓			✓			✓	2,3,5,6
A+B Bid w/Road User Cost Damage & Incentive.	✓	✓	✓	✓	✓		✓			✓	2,3,4,5,6
No Excuse Bonus								✓			2,3,4
Lane Rental									✓		

KEY TO GENERAL NOTES

1. General note requiring basic CPM.
2. General note required for specifying project specific daily road user cost value(s).
3. General note for establishing the beginning and ending of phases.
4. General note required for specifying project specific maximum number of days for incentive(s).
5. General note required for specifying project specific maximum number of days that can be bid.
6. General note required for establishing time between substantial completion and project acceptance (to be used when total time is not established by TxDOT).

CONTRACT PROJVISIONS (1993 Specifications Book)

1a. SP 001-108: Definition of Terms – daily road user cost and 5 days/week calendar day definitions.

1b. SP 001-109: Definition of Terms – daily road user cost and 6 days/week calendar day definitions.

1c. SP 001-110: Definition of Terms – daily road user cost and 7 days/week calendar day definitions.

2. SP 002-085: Instruction to Bidders – to submit working days.

3. SP 003-041: Award and Execution of Contract – consideration of bids being A+B.

8a. SP 008-151: Prosecution and Progress – Road User and Contract Administration Cost Liquidated Damages.

8b. SP 008-152: Prosecution and Progress – Incentive Provision.

8c. SP 008-117: Prosecution and Progress – bar chart or basic CPM schedules required to be submitted by contractor.

8d. SP 008-118: Prosecution and Progress – Advance CPM.

8e. SP 008-xxx: Prosecution and Progress – No excuse bonus incentive provision.

8f. SP 008-xxx: Prosecution and Progress – General lane rental provision. Addendum to special provision required with lane rental schedule.

9. SP 009-054: Measurement and Payment – Explains that the days bid are for comparison purposes only and not a pay item.

Contracting Strategies
ROAD-USER COST AND A+B BIDDING GUIDELINES

Reference Mr. Charles W. Heald, P.E. July 14, 1998 memorandum

PROJECT SELECTION GUIDELINES

PRIMARY CRITERIA: TYPES OF PROJECTS

- Projects that add capacity (may include grade separations).
- Projects where construction activities are expected to have an economic impact to local communities and businesses.
- Rehabilitation projects in very high traffic volume areas.

SECONDARY CRITERA:

- Conflicting utilities will be relocated prior to construction and the right-of-way is clear.
- There is an adequate inspection force available.
- 25% of the estimated road user cost is greater than the contract administrative liquidated damages.

If any of the secondary criteria is not met, the district should reevaluate the proposed use of road user cost liquidated damages before making the decision.

INCENTIVES: When the decision has been made to use road user cost, districts should include incentives with the disincentive. There may be occasion when the potential for discovery of unknown utilities during construction make it prudent to include road user cost as disincentives only. When including incentives, a maximum bonus (number of days) shall be included in the project proposal.

DAILY ROAD-USER COST VALUE: Only 25% of the calculated road user cost should be used for the rates shown in the plans. The daily rate for road user cost may only be applied to the point of completed (end phase) stated in the plans for each phase or substantial completion for the total project. Substantial completion is defined as occurring when all project work requiring lane or shoulder closure or obstructions is completed, and traffic is following the lane arrangement as shown on the plans for the finished roadway, or phase.

DEFINITION OF A WORKING DAY: Calendar definitions should also be used for all A+B and incentive projects and may be used on road user cost projects without incentives.

TABLE OF ROAD USER COST GUIDELINES

Suggested Road user Requirements	Type of Projects
A + B Bidding Strategy	May be used on projects with high volumes that have a significant impact on the local business or create road-user cost in excess of $40,000.00. A+B bidding should be used on a very limited basis. (CPM required)
Road User Cost with Incentive	The majority of projects with higher liquidated damages that meet the criteria in Mr. Wes Heald's guidance memo of 7/14/98 should use incentives. (CPM required)
Road user Cost without Incentive	May want to use road-user cost without incentives on projects where the risk of having utility conflicts is high, such as projects in older urban areas.
Contract Administration Liquidated Damages Only	Majority of TxDOT projects.

Contract Information Required for Road User Cost:

1. Working day definition.
2. Address work hours allowed (i.e. nighttime).
3. Cost per day for each phase and/or substantial completion.
4. Beginning of phases (if applicable).
5. Ending of phases (if applicable).
6. Maximum Bonus (number of days ahead of schedule) (incentive only).
7. Minimum days bid (A + B only).
8. *The time between substantial completion and project acceptance or the total time.*

ADDITIONAL GUIDANCE ON A+B BIDDING

1. When doing A+B bidding, the district has the option of setting the time between substantial completion and project acceptance (or the time suspension for end of project establishment, maintenance or performance periods) by general note, or setting the total time for the project regardless of the time bid by the contractor.

If TxDOT establishes the total time, then that number of days will be placed on the cover sheet as shown below.

> *"It is further understood that the work is to be completed in full in _210_ working days."*

When the time between substantial completion and project acceptance is specified by general note then an asterisk will be placed in the blank and a note will appear at the bottom of the cover sheet as shown below.

> *"It is further understood that the work is to be completed in full in __*__ working days."*
>
> *"*When the working days field contains an asterisk refer to the general notes or special provisions."*

Refer to general note number 6. The Design Division will have further instructions regarding placing the asterisk in the blank space.

2. An 800 item should be added for the contractor to be able to bid the number of days to substantially complete the project, or multiply items should be added for bidding the number of days to complete phases of the project. Please note that in A+B the contractor will bid the days to substantial completion, and will not bid the total time. The reason for bidding the days to substantial completion is because the daily road-user cost values are based on substantial completion. As indicated above, the district has the option of setting the number of days the contractor has to obtain final acceptance after substantial completion by using a general note or the district may specify the total time on the cover sheet. Refer to general note number 6.

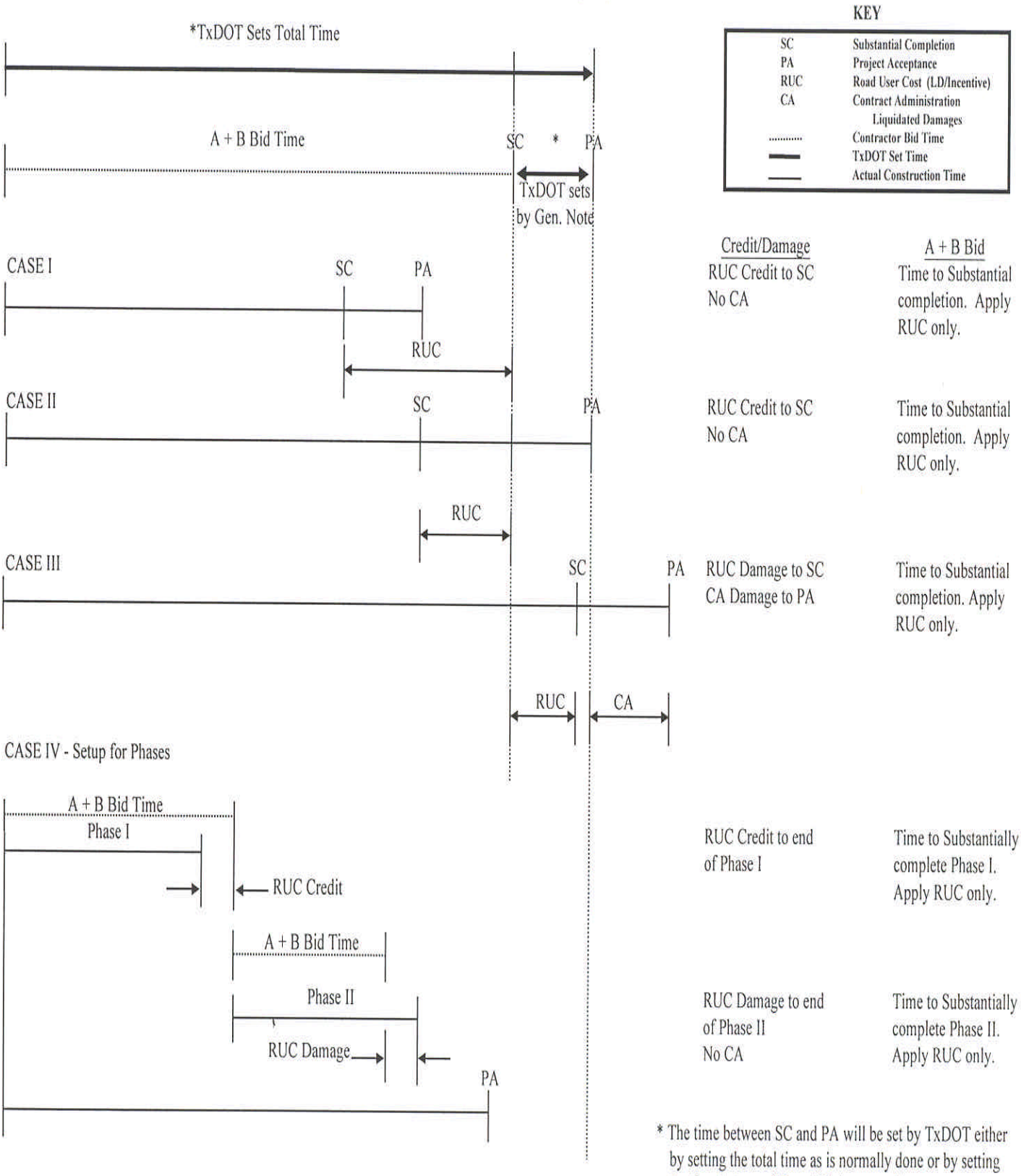
Add Item 800-XXX to proposal sheet as follows:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT BID PRICE
800-0505	Road-User Cost	$/DA	$XX,XXX	No. of days bid
or for bidding multiple phases as follows:				
800-050_	Road-User Cost Phase 1	$/DA	$XX,XXX	No. of days bid
800-050_	Road-User Cost Phase 2	$/DA	$XX,XXX	No. of days bid
800-050_	Road-User Cost Phase 3	$/DA	$XX,XXX	No. of days bid

Note that there is not an Item 800 specification or special provision. Additional guidance will be forthcoming regarding the tracking of incentive credits and road-user cost liquidated damage charges.

A + B Bidding: RUC Credit/Damage Scenarios With Incentive

(Schematic of Examples)



* The time between SC and PA will be set by TxDOT either by setting the total time as is normally done or by setting the time between SC and PA by general note.

CONTRACTING STRATEGIES:
EXAMPLE GENERAL NOTES

The general note numbers correspond with the ***Guide to Contracting Strategies & Contract Provisions.***

1. General note requiring basic CPM.

---ITEM 8.2---
The schedules will be required to be submitted in a CPM format.

2. General note required for specifying project specific daily road-user cost value(s).

WITHOUT MILESTONES
---ITEM 8.6---
The road-user cost liquidated damages shall be $ _____ per day.

WITH MILESTONES
Note that when setting up milestones on a project it is usually necessary to provide a detailed description of the work considered to be included in each milestone or phase. This may be done in a sequence of work special provision, the traffic control plans, or by general notes. The description should be clear, easily identified, and based on the shifting of traffic in the particular phases. It is especially important in establishing the beginning and ending of phases to base them on the shifting of traffic and not on general work areas. In our opinion, the contractor should be permitted to perform work on any phase provided such work is not detrimental to the scheduled phase in progress and does not conflict or affect the approved traffic control plans.

---ITEM 8.6---
The road-user cost liquidated damages for Phase 1 (Milestone 1) shall be $ _____ per day.
The road-user cost liquidated damages for Phase 2 (Milestone 2) shall be $ _____ per day.

The contractor shall have _____ working days to substantially complete Phase 1 (Milestone 1).
The contractor shall have _____ working days to substantially complete Phase 2 (Milestone 2).

Repeat as necessary.

3. General note for establishing the beginning and ending of phases.

Examples for establishing the beginning of phases:
---Item 8.5---
The time charges for the substantial completion of the project shall begin when time charges begin for the project.

The time charges for Phase _____ shall begin when traffic is moved to the lane arrangement shown in the traffic control plans for the phase.

The time charges for Phase _____ shall begin upon completion of the previous phase.

The beginning date of each milestone will be the date following completion of the previous milestone.

Examples for establishing the ending of phases:

---Item 8.5---

The time charges for Phase _____ shall end when traffic is moved to the lane arrangement shown in the traffic control plans for the succeeding phase.

The time charges for Phase _____ shall end upon the beginning of the succeeding phase.

The ending date of each milestone will be the date preceding the beginning of the succeeding milestone.

4. **General note required for specifying project specific maximum number of days for incentive(s).**

---ITEM 8.11---
The maximum number of working days for computing the incentive credit shall be _____ days.

5. **General note required for specifying project specific minimum number of days that can be bid when doing A+B bidding.**

---ITEM 2.5---
The minimum days that can be bid for the substantial completion of Phase 1 is _____.
The minimum days that can be bid for the substantial completion of Phase 2 is _____.
The minimum days that can be bid for the substantial completion for the project is _____.

6. **General note required for establishing time between substantial completion and project acceptance (to be used when total time is not established by TxDOT).**

The number of working days for final acceptance will be 60 working days after the substantial completion of the project.

CONTRACTING STRATEGIES:
CONTRACT PROVISIONS

Special Provision Numbers are referenced to the 1993 Specifications Book (Blue). The numbers on the left correspond with the ***Guide to Contracting Strategies & Contract Provisions.***

1a. SP 001-108: Definition of Terms – daily road user cost and 5 days/week calendar day definitions.

1b. SP 001-109: Definition of Terms – daily road user cost and 6 days/week calendar day definitions.

1c. SP 001-110: Definition of Terms – daily road user cost and 7 days/week calendar day definitions.

2. SP 002-085: Instruction to Bidders – to submit working days.

3. SP 003-041: Award and Execution of Contract – consideration of bids being A+B.

8a. SP 008-151: Prosecution and Progress – Road User and Contract Administration Cost Liquidated Damages.

8b. SP 008-152: Prosecution and Progress – Incentive Provision.

8c. SP 008-117: Prosecution and Progress – bar chart or basic CPM schedules required to be submitted by contractor.

8d. SP 008-118: Prosecution and Progress – CPM schedules prepared using Suretrak or Primavera required to be submitted on computer diskettes.

9. SP 009-054 (040): Measurement and Payment – Explains that the days bid are for comparison purposes only and not a pay item.

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Tracking Projects With Road User Costs

MEMORANDUM

TO: District Engineers November 18, 1998

FROM: Thomas R. Bohuslav, P.E.

SUBJECT: Tracking Projects with Road User Costs

Please reference Mr. Heald's memorandum dated July 15, 1998 (copy attached) that outlines the guidelines for implementing Senate Bill 370 Section 223.012 – Travel Delay Costs (Road user Costs).

The Construction Division will be tracking payment of incentives and disincentives. We believe that there are five possible scenarios that meet the criteria set forth in Senate Bill 370. In order to track the payment of incentives and disincentives, standard item and description codes have been assigned as described in the table below. Please use these new standard items and description codes when you prepare your next estimate. Instructions for adding these standard items to the construction estimate can be found in the "Add/Delete Items of Work (M2)" section of the "Construction Estimate" chapter in the ***CIS District User Manual***.

Projects with:	Description of Payment/Deduct:	Note:
A+B 9500-0507 (English) 9500-0507 (Metric)	Credit or Damage Item Description – A&B CREDIT OR DAMAGE* *Units should be Lump Sum. (L.S.)*	To be used on projects that have a B component in the bid
RUC (Road User Costs) (with Credit or Damage) 9500-0508 (English) 9500-0508 (Metric)	Credit or Damage Item Description – RUC CREDIT OR DAMAGE* *Units should be Lump Sum. (L.S.)*	Projects with incentives
RUC (Road User Costs) (with Credit or Damage) 9500-0509 (English) 9500-0509 (Metric)	Damage Only Item Description – RUC DAMAGE* ONLY *Units should be Lump Sum. (L.S.)*	Projects that have higher liquidated damages w/no incentives
Third Party (Credit Only) A+B or RUC 9500-0510 (English) 9500-0510 (Metric)	Credit Item Description – RUC/A+B (CREDIT to be paid by THIRD PARTY) *Units should be Lump Sum. (L.S.)*	Projects where third parties are responsible for credit; i.e. malls, special events centers

*Negative numbers would be used when a damage is involved.

If you have any questions, please contact Roger Cisneros, P.E. at 512/416-2450 or George Lueck, P.E. at 512/416-2461.

Your usual cooperation will be appreciated.

Attachment

Cc: Mike Behrens, P.E.
Design Division
District Construction Engineers
bc: Aldridge, Cisneros, Hundley

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Beginning of linked document:

Senate Bill 370 Section 223.012 - Travel Delay Costs (Road User Costs)

MEMORANDUM

TO: District Engineers July 14, 1998

FROM: Charles W. Heald, P.E.

SUBJECT: Senate Bill 370 Section 223.012 – Travel Delay Costs (Road User Costs)

Senate Bill 370 passed by the 75th Legislature and signed into law by Governor Bush requires TxDOT to "develop a schedule of liquidated damages that accurately reflects the costs associated with project completion delays, including administrative and travel delays." Travel delay costs are commonly referred to as road user costs. The purpose of this memorandum is to provide guidance for the implementation of this legislation.

The guidelines outlined herein are to be used as an aid when making decisions on whether to require road user cost on projects. Road user cost should be considered for the following types of projects:

- Projects that add capacity (may include grade separations).
- Projects where construction activities are expected to have an economic impact to local communities and businesses.
- Rehabilitation projects in very high traffic volume areas.

In addition to meeting at least one of the above, a secondary evaluation should be made considering the following:

- Conflicting utilities will be relocated prior to construction and the right-of-way is clear.
- There is an adequate inspection force available.
- 25% of the estimated road user cost is greater than the contract administrative liquidated damages.

If any of the secondary criteria is not met, the district should reevaluate the proposed use of road user cost liquidated damages before making the decision.

When the decision has been made to use road user cost, districts would include incentives with the disincentive. There may be occasion when the potential for discovery of unknown utilities during construction make it prudent to include road user cost as disincentives only. When including incentives, a maximum bonus (number of days) shall be included in the project proposal. Further, only 25% of the calculated road user cost should be used for the rates shown in the plans. Calendar definitions should also be used for all A+B and incentive projects and may be used on road user cost projects without incentives.

The daily rate for road user cost may only be applied to the point of completed (end phase) stated in the plans for each phase or substantial completion for the total project. Substantial completion is defined as occurring when all project work requiring lane or should closures or obstructions is completed, and traffic is following the lane arrangement as shown on the plans for the finished roadway, or phase.

Questions on the proper use of road user costs for projects should be directed to the Design Division. Questions on calculations and traffic software programs should be directed to Henry Wickes at 512-416-3157 or Allison Meadors at 512-416-3244 of the Traffic Operations Division.

Attachment
cc: CST, DES, TRF, TPP, MNT

Attachment to Memorandum dated July 14, 1998 from Charles W. Heald, P.E. to District Engineers
Re: Senate Bill 370 Section 223.012 – Travel Delay Costs (Road user Costs)

TABLE OF ROAD USER COST GUIDELINES

Suggested Road user Requirements	Type of Projects
A + B Bidding Strategy	May be used on projects with high volumes that have a significant impact on the local business or create road-user cost in excess of $40,000.00. A+B bidding should be used on a very limited basis. (CPM required)
Road User Cost with Incentive	The majority of projects with higher liquidated damages that meet the criteria in Mr. Wes Heald's guidance memo of 7/14/98 should use incentives. (CPM required)
Road user Cost without Incentive	May want to use road-user cost without incentives on projects where the risk of having utility conflicts is high, such as projects in older urban areas.
Contract Administration Liquidated Damages Only	Majority of TxDOT projects.

Contract Information Required for Road User Cost:

1. Working day definition.
2. Address work hours allowed (i.e. nighttime).
3. Cost per day for each phase and/or substantial completion.
4. Beginning of phases (if applicable).
5. Ending of phases (if applicable).
6. Maximum Bonus (number of days ahead of schedule) (incentive only).
7. Minimum days bid (A + B only).
8. *The time between substantial completion and project acceptance or the total time.*

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Form 1002

P. S. & E. Submission Data

Texas Department of Transportation

Form 1002
(Rev. 9/2001)
(GSD-EPC Word 97)

Date _____

This form should be completed and submitted with supporting papers. Complete this form for the Controlling project in contract. (Complete all Blanks. State N/A if necessary.)

District _____ Proposed Letting Date _____
County _____ Project _____
Control _____ Highway _____ Length _____
Limits _____

A. **Supporting Papers Checklist**

	Description	**No. Copies Required**	**No. Copies Attached**
(1)	List of Governing Specifications and Special Provisions	*	
(2)	General Notes and Specification Data GroupWise to processing office.	*	
(3)	Plans Estimate	*	
(4)	New Special Provisions and Special Specifications GroupWise to processing office with Form 1814.	*	
(5)	Triple Zero Special Provisions GroupWise to processing office.	3	
(6)	Engineer Sign, Seal and Date Supplemental Sheets (8 ½" x 11" Originals)	2	
(7)	Contract Time Determination Summary	1	
(8)	Right of Way and Utilities: Certifications-		
	Right of Way	3	
	Relocation Advisory Assistance	3	
	Encroachments	3	
	Utilities	3	

ROW Status	Relocation Status	Utility Status	Encroachment Status
☐ Clear	☐ Clear	☐ Clear	☐ Clear
☐ To be Clear	☐ To be Clear	☐ To be Clear	☐ To be Clear

(If ROW, Encroachments, and/or Utilities are NOT CLEAR, Submit a Triple Zero Special Provision.)

(9)	Temporary Road Closure Request	3	
(10)	Construction Speed Zone Request	3	
(11)	Review Plans Prints:		
	Federal Funded HES Projects	6(**)(***)	
	Federal Funded Projects - With Federal Oversight	5(**)(***)	
	Federal Funded Projects - With State Oversight	4(**)(***)	
	State Funded Projects	4(**)(***)	
	Surface Treatment and ACP Projects	3(**)(***)	
	Traffic Signal & Signing Projects	3(**)(***)	
	Intelligent Transportation System (ITS) Projects	6(**)(***)	
	District Review Projects	1	

* The number of copies of supporting papers will be one more than the number of review plans prints as shown in Item 11.
(**) Submit 1 add'l set of review plans for hike/bike or building projects OR if est. cost of pedestrian elements exceeds $50,000.
(***) Submit 1 add'l set of review plans if PS&E contains any **one** or more of the following bid items: 610, 611, 612, 613, 614, 618, 620, 622, 624, 628 or 629.

B. **STIP Year** _____ **STIP Page #** _____

C. **Financing**

CSJ	Work Program No.	Authorized Funds	Estimated Funds (excl. E&C & other part.)	Overrun/Underrun (+/-)
		$	$	$ 0.00
				0.00
				0.00
				0.00
	Total	$ 0.00	$ 0.00	$ 0.00

Attach separate sheet explaining overruns of programmed amounts. (In accordance with current Department Program Overrun policy.)

Other Participation:

	Amount	Indicate Fixed Sum or Actual Cost	Authorization Minute Order No.
County _____	$		
City _____			
Other (Specify) _____			

Attach any necessary funding agreements.

D. **Agreements**

(1) Railroad Agreements
Required: Yes ☐ No ☐ Name of Railroad _____
Date Executed _____ If Not Executed, Date Request Sent to TRF _____

(2) Other Agreements Required Yes ☐ No ☐
Name of Agency _____
Purpose _____
Executed Yes ☐ No ☐

E. **Airway-Highway Clearance**
Required Yes ☐ No ☐ Date Approved _____

F. **Contract Time**
Working Days _____ or Calendar Days (Special Provision to Item 1 Required) _____

G. **Project Manager in Charge of Construction Contract**
Engineer No. _____
Name _____
Address _____

(Show on Contract Summary (C1) Screen in DCIS.)

H. **District Contact Person**
Name _____
Telephone No. _____
Fax No. _____

I. Estimated Cost
Pedestrian Elements $ _____

J. **Comments**

PROPOSED BASIC DESIGN DATA

District _____ County _____
Control _____ Project No. _____
Highway _____ Limits _____
Length _____ | _____
(English) (Metric)

Work Program Title(s) _____

Work Type (Layman's Description) _____

Proposed Design Standards (Structures) _____
Proposed Design Standards (Roadway) _____
Proposed Design Standards (Traffic) _____
Design Speed (Applicable): _____ ☐ mph ☐ km/h Terrain _____
Traffic: Existing _____ Projected (20 years) _____
Highway Functional Class (Urban) _____ (Rural) _____

Design Criteria Recommended for Approval (District)
Date _____
Signed _____
Title _____

Design Criteria Approval (Division)
Date _____
Signed _____
Title _____

Exceptions Requested

(List and indicate occurrence, i.e., over total project, at 3 locations, at 1 structure, etc.)

1. _____
2. _____
3. _____

Waivers Requested

1. _____
2. _____
3. _____

Design Exception Recommended for Approval: (District)
Date _____
Signed _____
Title _____

Waiver Recommended for Approval: (District)
Date _____
Signed _____
Title _____

EXCEPTION COMMITTEE
(To be filled out in Austin)

_____ Bridge Design
_____ Roadway Design
_____ Bicycle Lanes
_____ Traffic

Recommended Action:

Approval ☐ Non-Approval ☐
Reasons _____

Date _____
Signed _____
Deputy Director, Design Division

WAIVER COMMITTEE
(To be filled out in District Office)

_____ Bridge Design
_____ Roadway Design
_____ Bicycle Paths
_____ Traffic

Recommended Action:

Approval ☐ Non-Approval ☐
Reasons _____

Date _____
Signed _____
(Title)

ALTERNATIVE CONTRACTING PROCEDURES

Attachment A to Form 1002

District _____ County _____
Control _____ Project No. _____
Highway _____ Limits _____

The following types of projects are good candidates for the use of accelerated construction contract provisions. Check all that apply to this project:

☐ Interstate or freeway project with lane closures during one or more phases of construction

☐ Bridge closure (either as the entire project or a portion of a larger project)

☐ Road closure

☐ Added Capacity projects

☐ Non-freeway with ADT >10,000 and lane closures during one or more phases of construction

☐ Provides access to a nearby school, emergency services (hospital, fire, etc.), or major traffic generator

☐ Project affects access to adjacent businesses

☐ None of the above (disregard remainder of this page)

If any of the above criteria apply, are accelerated contract provisions (calendar days, increased liquidated damages, incentive/disincentive, A+B, lane rental) included on this project?

☐ YES ☐ NO

If not, explain why accelerated contract provisions were not utilized:

_____

_____

_____

_____

_____

End of linked document. Click button to return to source document.

Beginning of linked document:

CPM Scheduling

Critical Path Method Schedule Development, Review and Analysis Guidelines

Compiled by Mike Lehmann, P.E.
District Construction Engineer
San Antonio District

December 7, 2001

Critical Path Method Schedule
Development, Review And Analysis Guidelines
Preface

This document was originally prepared for the purpose of providing guidance to schedule users in the San Antonio District. While the document itself has evolved over a three-year period, it reflects over 15 years of knowledge and experience with CPM scheduling. Many individuals contributed significantly to this document including Bob Hundley, Jose Hernandez, Tracey Friggle, Juan Urrutia, Craig Clark, Jennifer Moczygemba, Annie Dadian-Williams, Greg Biediger, Darrel Brown, and Charlie Shook.

It is recognized that other methods exist and these methods may produce fully acceptable results. It is not the intent of this document to discredit other methods or to discourage creativity and flexibility. Rather, it is the intent of this document to provide schedule users with a set of approaches, techniques and methods that have been proven over time as acceptable.

It is also recognized that these guidelines cannot cover every situation one may encounter when creating schedules, reviewing schedules or analyzing delays. These guidelines may serve as a starting point for analyzing these unique situations.

Chapter 1
Development Of Critical Path Method Schedules For Contract Time Determination

Overview

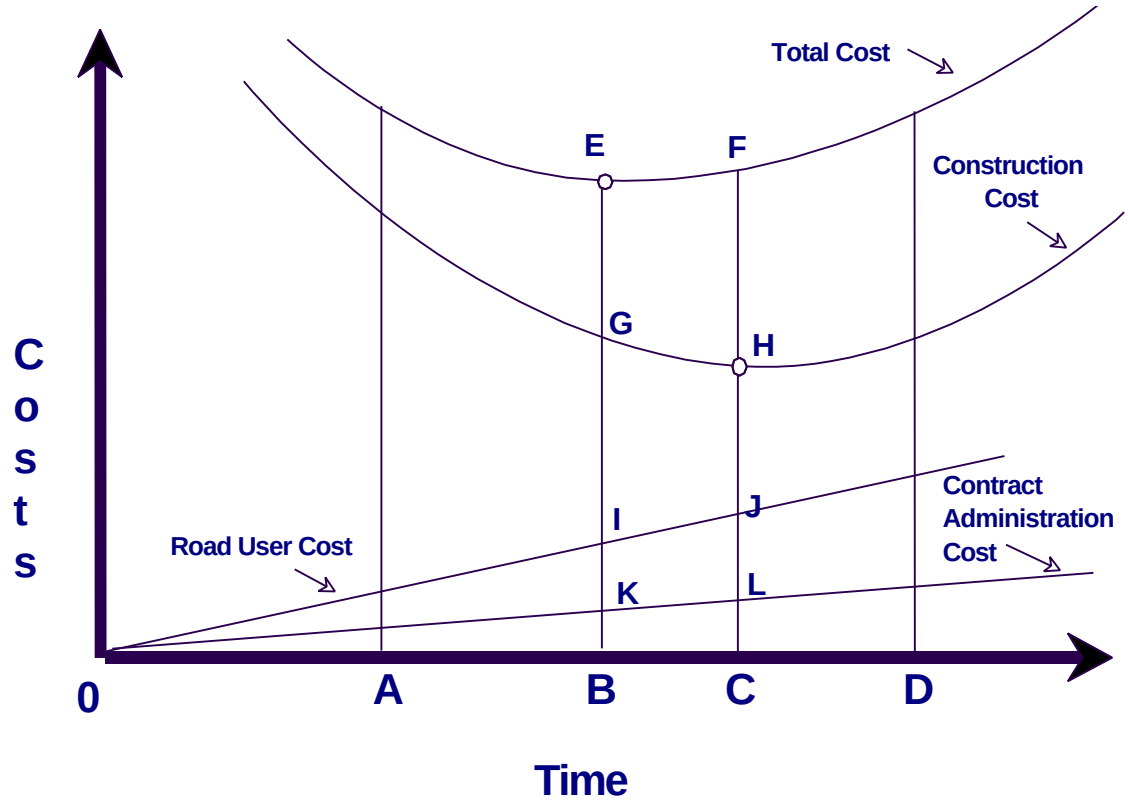
Contract time administration for a construction project starts during the PS&E preparation stage. The amount of time set up for a project during PS&E development can greatly affect the ease or difficulty of contract time administration during construction. If too little time is allowed for a project or milestone, the Contractor will be pressured from the onset to avoid liquidated damages. The Contractor will be more likely to request additional working days for each and every impact that might occur, including those that may not merit additional time. In addition to the obvious effects of adding work and complicating life for project personnel, this can lead to hard feelings and a loss of the partnering relationship needed for a successful construction project. Most importantly, setting up too little time for a project increases unit bid prices.

Setting up too much time for a project is also detrimental. Obviously, setting up too much time for a project does not contribute to the department's goal of project acceleration. Also, if a Contractor has too much time to do the work, they may feel compelled to move their crews and equipment to more urgently pressing projects. Having a roadway lined with traffic barrier and barricades while no work is underway leads to adverse public relations.

Figure 1 on the following page shows the relationship between cost and time for a theoretical construction project. The curve titled "Construction Cost" shows that the project has an optimum duration of "C" working days. For a Contractor to complete the project in less than this time may require additional resources (labor, equipment and subcontracts), more expensive materials (fast-setting concrete, pre-cast bridge components, etc.) or both. If the duration of the project extends past the optimum point, time-related costs such as project overhead (portable office trailers, project supervisory personnel, etc.) can increase the cost of the project. This curve may differ from Contractor to Contractor. Hopefully, when TxDOT issues PS&E, the time allocated allows Contractors to bid the lowest cost point on the curve.

The straight lines at the bottom of the graph represent "Road User" and "Contract Administration" costs. These costs are time-related. The longer the project continues, the higher these costs. The total cost of the project is the total of the construction, road user and contract administration costs. In this example, the lowest **total** project cost occurs at "B" working days.

Figure 1
Cost Versus Time



Thus, the goal is to set up the right amount of time for a project. To do this, it is important to create some sort of schedule based on the quantities and difficulty of work, the sequence of work and the traffic control plans included in the PS&E. For some projects, a simple bar chart may suffice. For some projects, nothing but a fully detailed CPM schedule will do. For many projects, a basic CPM schedule is sufficient. The key is to create a schedule commensurate with the complexity and size of the project itself.

Time Determination Basics

Regardless of the type of schedule to be created, the following steps are needed.

Step 1. Understand The Sequence Of Work And Traffic Control Plan In The PS&E

If a roadway could be completely closed to traffic, determining contract time would be an easy task. The reality, however, is that we must build projects under traffic. Traffic changes, lane closures, and detours typically determine the quantities of work available at any given time. These restrictions will also affect production rates. If a realistic time determination schedule is to be developed, it

must be done following the sequence of work and traffic control plan shown in the PS&E.

Step 2. Calculate/Estimate Quantities Of Work By Phase

Once the sequence of work and traffic control plans is understood, it is possible to either calculate or estimate the quantities of work per phase. This information is essential to assign each work activity within each phase or stage an accurate duration.

Step 3. Determine Attainable Production Rates

Once the quantities of work per phase are known, it is possible to determine attainable production rates for the various types of work. Factors that should be considered when estimating productivity rates include:

- Quantity of work
- Difficulty of work
- Time restraints
- Ease of access to the work
- Local site drainage implications
- Type of soil expected
- Material availability
- Special ornamental or decorative features
- Special considerations including
  - Pre-cast versus cast-in-place
  - Slipform versus formed concrete work
  - Daytime versus nighttime work

It is recommended that the productivity estimates be determined for one average crew performing the particular activity given the special considerations above. If it is later decided that sufficient space and work is available for two crews to work on the same activity, the productivity rate can be doubled.

Unfortunately, TxDOT does not have a comprehensive database of productivity rates available at the time of this writing. However, hope is on the way. TxDOT has contracted with the Center for Transportation Research at the University of Texas at Austin to conduct Research Project 0-4416*, Development of Improved Information for Estimating Construction Time*. This research project will develop a production rate database as one of its deliverables. Until this database is available, refer to Chapter 3 of *Project Delivery and Project Management for TxDOT Projects* for more information. Experienced department employees and helpful Contractors may supplement information included in this document.

Primavera Basics

The schedule creation, review and analysis processes in this document were developed assuming Primavera Project Planner (P3) will be used. The review

steps are presented using P3's pull-down menus. P3 allows shortcut keystrokes and desktop icons to perform the same functions. Schedulers are encouraged to learn these timesaving options on their own initiative.

The following symbols, formats, and terminology are used in this document:

Terminology	Use	Symbol/Format
Radio Dial	To select one of several options	⊙
Pick List	To select system and user-defined data	▼
Plus button	To add an activity, relationship, etc., to the current window	+
Minus button	Removes the highlighted data from the current window	-
Menu or window option	Pull-down menus, buttons in active windows	**Command**
Area in active window or screen name	To help user locate specific data discussed in text	*Italics*
Titled areas, columns, etc.	To identify specific areas in active window	"Title"

Where appropriate, screen prints from Primavera Project Planner are incorporated into this document for clarity or to demonstrate a point.

Schedule Development – Detailed Information

The development of a CPM schedule for contract time determination may seem to be an overwhelming task. It is best to view this entire process as a series of individual steps, each building upon products of the previous steps. It is therefore important to follow these steps in the recommended order.

Step 1. Break Down The Work Into Distinct Activities

One of the first questions a developer of a time determination schedule asks may be "How many activities should I use?" Unfortunately, there is no one answer to this question. A good starting point is to include activities from the following list for each phase of the project:

- Mobilization
- Initial SW3P Setup
- Initial Traffic Control and Detours
- Placement of CTB
- Prepare ROW or Clear and Grub
- Utility Adjustments
- Utility Installations
- Remove Old Structure (Pavement)
- Remove Old Drainage/Utility Structure
- Earth Excavation
- Earth Embankment
- Rock Excavation
- Drainage Structures – Pipe

- Drainage Structures – Box Culverts
- Drainage Structures – Inlets and Manholes
- Bridge Demolition
- Cofferdams
- Bridge Piling or Drilled Shafts
- Bridge Footings
- Bridge Columns, Caps and Bents
- Bridge Abutments and Wingwalls
- Bridge Beams
- Bridge Deck – Forming, Rebar and Placing Concrete
- Curing Time for Bridge Deck
- Bridge Rail
- Retaining Walls
- Base Preparations
- Lime Stabilization
- Flexible Base
- Cement Treated Base
- New Curb/Gutter
- Sidewalks and Curb Ramps
- Hot Mix Asphalt Base
- Concrete Pavement
- Prime Coat, Seal Coats and Surface Treatments
- Hot Mix Asphalt Surfacing
- Permanent Signs and Striping
- Major Traffic Signals
- Overhead and Cantilever Signs
- ITS Systems
- Illumination
- Seeding and Landscaping
- Final Cleanup and Demobilization

Of course, each project will have its unique set of activities. The key is to include enough detail to adequately model the anticipated sequence of construction without getting bogged down in too much detail.

After the list of activities is developed, calculate or estimate the quantity of work for each item on the list. Then, start deciding on productivity rates for these items. The duration of each activity should be the result of dividing the quantity of work by the estimated productivity rate.

Step 2. Create The New Schedule

Create a new schedule in Primavera by following these steps:

- Click **File**, **New**
- Change the directory to the desired location.
- Enter a four-digit project name in the *Project name* box. Primavera requires **exactly** a four-digit name. The name may use any combination of letters and numbers. Do not use special characters like &, * or #.
- Enter project descriptive information in the *Number/version*, *Project title*, and *Company name* boxes.
- For most projects, the default *Planning unit* of Day is adequate.
- Enter an anticipated project *Start date.* This can be done by entering the date in DDMMMYY format or by using the pick list (▼) to access a calendar.
- Leave the *Project must finish by* box empty to allow the program to calculate the end date.
- For most projects, use the defaults for the remaining information.

- Click **Add** and P3 will create the files needed to create the schedule.
- When the files are created, P3 will present a blank project in the "insert" mode. P3 is expecting the user to start entering activity data. To get out of the insert mode, press the **Escape** key or click the **X** button at the top left part of the screen.

Step 3. Set Up The Calendars For Modeling Non-Work Days

Calendars are used to account for non-work periods including weekends, holidays, and assumed bad weather days.

Work Week

For most projects, it is reasonable to start with the assumption that the standard work week, before weather considerations are added, to be five days per week.

Holidays

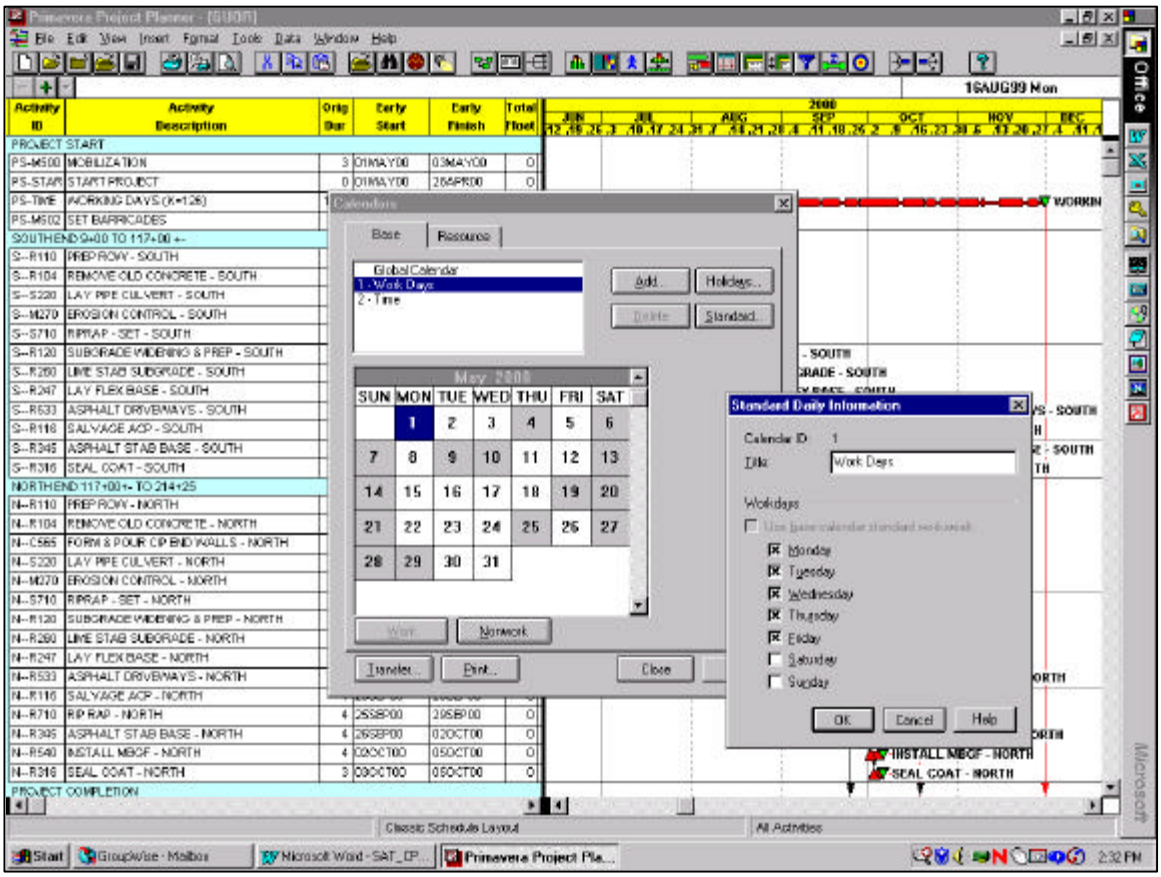
Certain holidays are mandatory non-work days specified in the contract. In addition, some Contractors do not work other holidays or the days before and after holidays.

Bad Weather Days

Days lost to rain, snow, site being too wet, etc. can be estimated by looking at historical weather data and accounted for in the calendars as non-work days. Some schedulers may try to consider the impact of weather within the activity durations. This is not a recommend practice, however, because the effects of the weather cannot later be isolated from other impacts.

Typical Construction Calendars

0 Global calendar: holidays only as non-work days.
1 Dirt work calendar: rain days and too wet as non-work days.
2 Bridge work calendar: rain days only as non-work days.
3 Curing calendar: concrete cures 7 days/week.
4 Asphalt calendar: models asphalt season.
5 Mall calendar: no work during holidays around the mall.
6 Seeding calendar: models growing seasons.
T Contract time calendar: models how time will be administered.

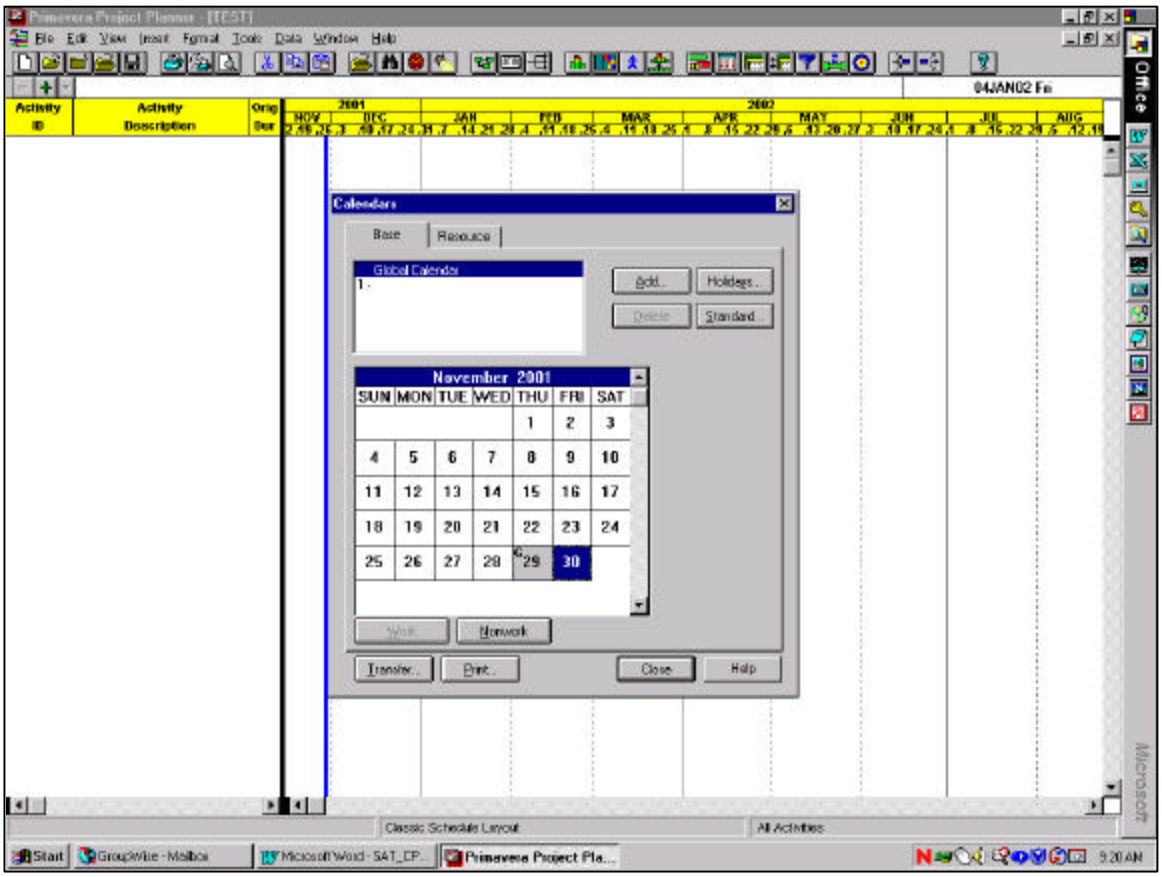


Primavera allows multiple calendars to be used. The goal is to get as close to reality as possible.

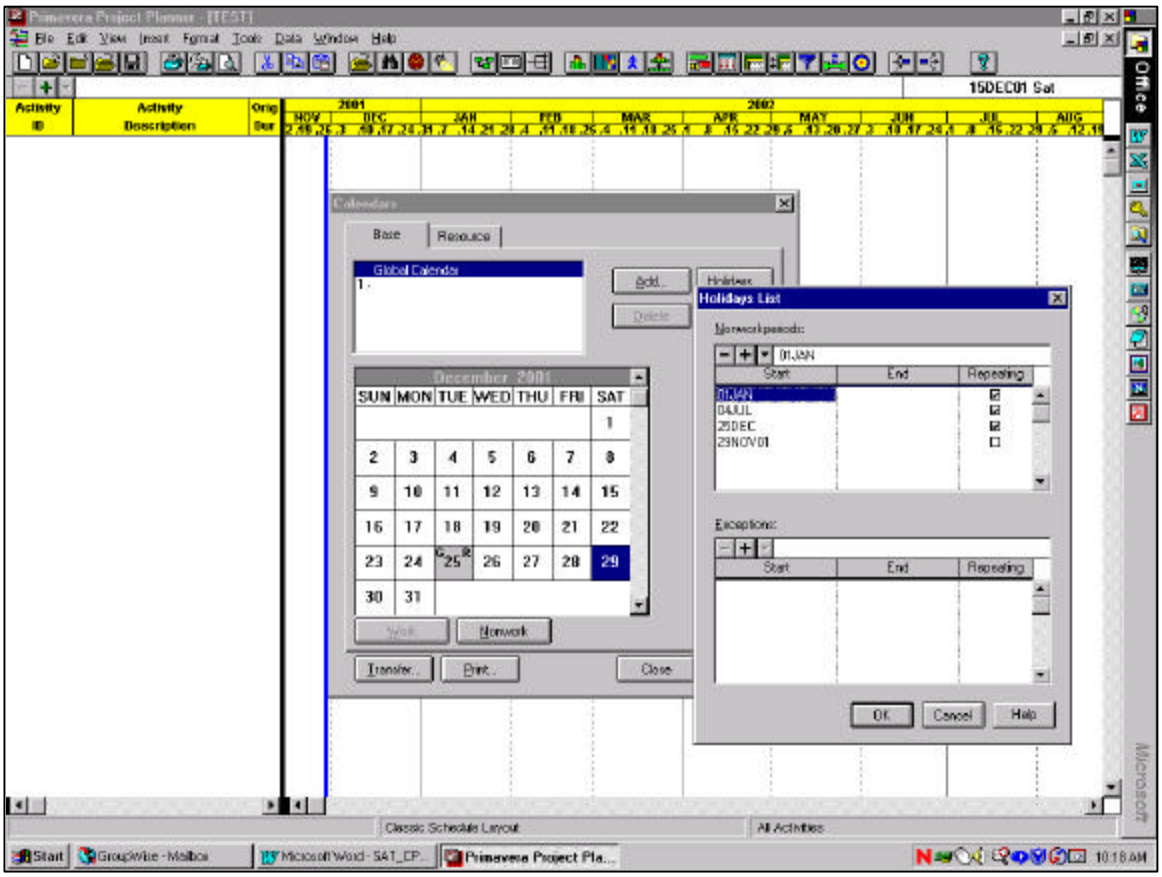
In the example above, the Work Days calendar shows a normal work week of five days per week. Non-work days are randomly marked (grayed-out days) to account for bad weather. Note that no work is scheduled for Monday, May 29. This is to allow for the Memorial Day holiday. Note also that a separate calendar has been created to track how contract time will be administered. This is an excellent scheduling practice.

To create project calendars in P3, follow these steps:

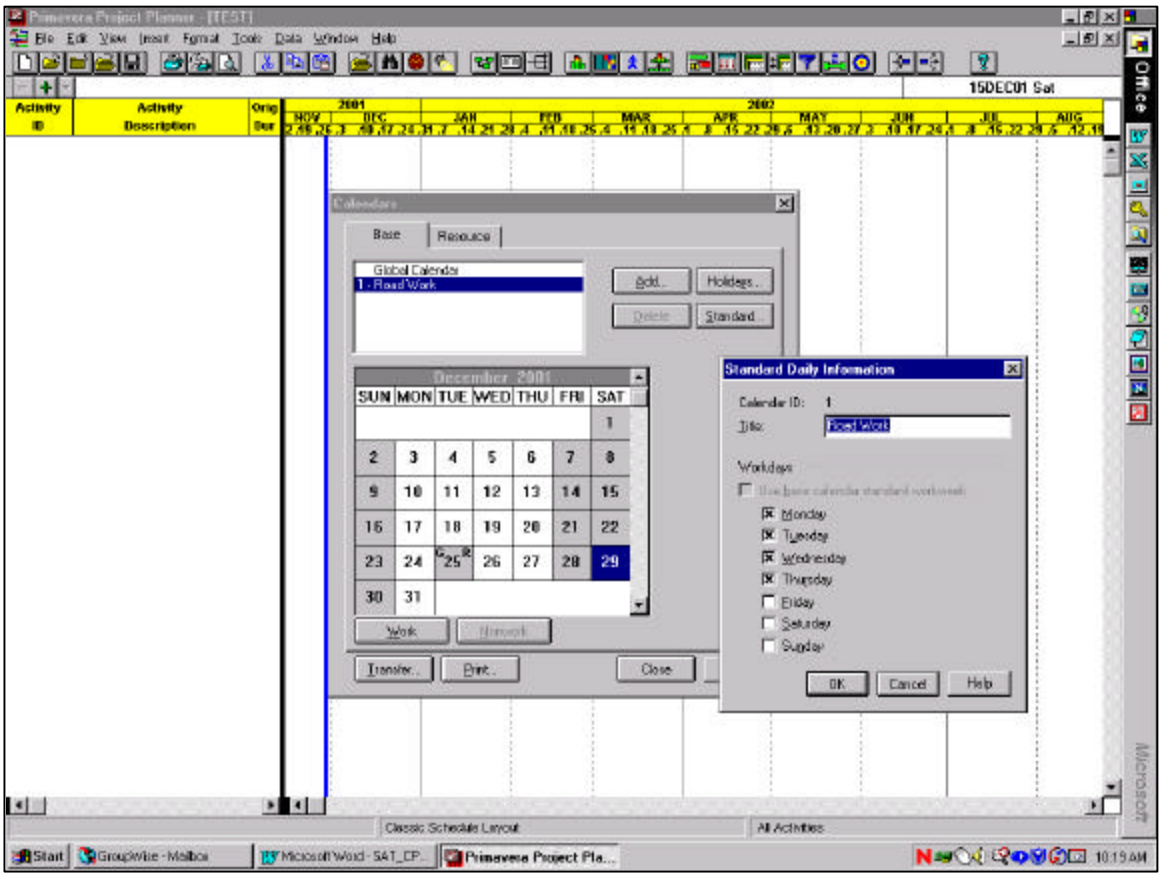
- Click **Data**, **Calendars**
- Highlight the *Global Calendar*.
- Scroll through the year and highlight one of the six major holidays. Click the **Nonwork** button. This grays out the day and identifies the day as a global non-work day (note the “G” in the calendar). Repeat this for all the holidays to be marked as non-work for the duration of the project. See the example below.



- Note that some holidays are on the same day each year. New Year's Day, Independence Day and Christmas are always on the same day of the year. Making these holidays *Repeating* makes them non-work for all the years of the project. See the example on the following page. Note that once these holidays are made repeating, the year no longer appears in the date format in the *Holidays List*. Note also that an "R" appears in the calendar itself. It is also important to note that all holidays that are set up in the Global calendar will appear in all the calendars in the schedule. If curing time is significant enough to set up a separate calendar for, the curing calendar will show the holidays as non-work. This may be corrected by scrolling through the curing calendar, highlighting the holidays and changing them to work days.



- Next, set up the individual calendars. It is easiest to start out by modifying Calendar 1. Primavera defaults to Calendar 1 for newly added activities. It is therefore logical to make Calendar 1 the most commonly used calendar. If the project is predominately road work, make Calendar 1 the Road Work calendar. If the project is mostly bridge work, make Calendar 1 the Bridge Work calendar. To do this, highlight Calendar 1, click **Standard**, and enter the name of the calendar.
- With the *Standard* window open, it is easy to change the calendar to show the desired number of working days per week. This can be done by clicking the "x" box next to weekdays. Removing the "x" makes the day a non-work day. In the following example, the Road Work calendar is made a standard four day work week.



- Depending on the part of the state the project is and the type of work involved, it may be unreasonable to assume Road Work can take place four days a week in December (four days per week may be reasonable in July, however). Therefore, it is important to mark additional days as non-work. To do this, highlight a day and click the **Nonwork** button. Pressing and holding the **Control** key will allow the scheduler to highlight several days at a time. They may then be made non-work by clicking the **Nonwork** button. Scroll to the next month and repeat this process.
- Add any additional calendars by using the **Add** button and using the procedures discussed above.
- Make sure to add a calendar that models how contract time will be charged (working days or calendar days)

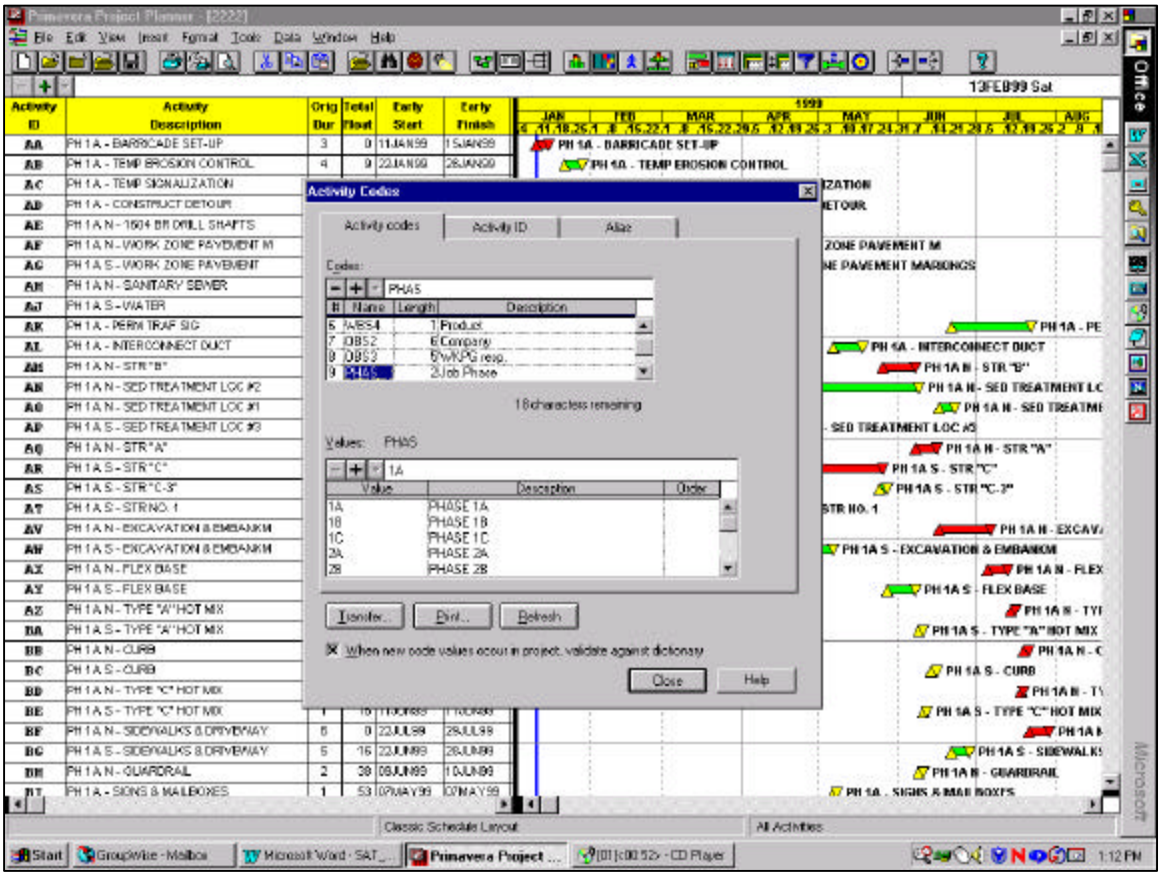
Step 4. Set Up Coding For Organizing The Schedule

A good coding structure is essential for grouping activities for reporting and plotting purposes. The lack of useable activity coding in CPM schedules can be one of the biggest setbacks to getting the full benefit of the schedule. There are many instances where project personnel have given up and abandoned the schedule because the networks resemble electrical wiring diagrams and were impossible to understand.

Many individuals and entities must effectively communicate to successfully complete a project. Each person or entity has different information needs. For instance, administrative personnel may need to have just a broad overview of the project. This is can be provided by project phase coding. Project managers may need more detail that can be provided by Phase and Area coding or Area and Location coding used together. The paving inspectors are more interested in when the paving work is scheduled. The work type or work item coding would be used to generate the information for these inspectors. The work type and work item coding is also useful for project managers to effectively manage resources.

Below is the start of a hierarchical list of recommended coding, however, the best coding structure will be unique to each project.

Code	Values	Description
Phase	1	Phase 1
	2a	Phase 2a
	2b	Phase 2b
Area	LFR	Left Frontage Road
	RFR	Right Frontage Road
	RML	Right Mainlane
	LML	Left Mainlane
Location	INT1	Specific Intersection
	RAM1	Specific Ramp
	STR1	Specific Structure
	STAX	Roadway Station to Station
Responsibility	CONT	Prime Contractor
	SUB1	Subcontractor
	SUP1	Supplier
	DOT	TxDOT
Work Type	PROJ	Project Wide
	SDRN	Storm Sewers
	UTIL	Utilities
	EXCA	Excavation and Embankment
	LTS	Lime Treat Subgrade
	BASE	Base
	PAVE	Paving
	STR1	Bridge Structure Nos
Work Item	100	Prep ROW
	110	Excavation
	132	Embankment
	260	Lime Stabilization



In the example above, the schedule includes coding for many different items. Some of these are of interest to the Contractor only (WBS4, OBS2 and OBS3). TxDOT would be interested in coding by Job Phase (PHAS), which would allow the schedule to be organized consistent with the sequence of work and traffic control plan shown in the PS&E.

To create a coding structure like the example above, follow these steps:

- Click **Data**, **Activity Codes**
- Primavera will display the default activity code structure. It is possible to modify this coding structure to meet the particular project, however, it is just as easy to delete the default code structure and start over. To do this, highlight the name of the code to be deleted in the *Codes* section of the window and click the – button. Continue the deletion until the code structure is blank.
- Add desired code classifications (names) by clicking the + button. Type a four-character name and click the ✓ button. Highlight the length field and adjust the length of the code field as desired. The length of this field will limit the length of code values that can be entered. Four characters is usually a

good length. Highlight the description field and enter a description of the code classification. Click the ☑ button.

- Click in the *Values* section of the screen. Primavera will prompt the user "Save structure edits?" Click **Yes**. Click in the *Values* section of the screen again and highlight the *Value* column. Enter the first code value and click the ☑ button. Highlight the *Description* field to the right of the newly created code value, type a description and click the ☑ button. Note that P3 will automatically sort plots and prints that may later be organized using this coding and will default to ascending alphanumeric sorting unless the *Order* field is used. For codes like Phase, where the values of 1, 2, 3A, 3B, etc., will produce the desired sort order, the order field is redundant. Keep in mind that the order column may be used to force the program to sort data the way the scheduler wants the data to be sorted.
- Repeat these steps as necessary to add all the desired coding to the project.

Step 5. Enter Basic Activity Information

Project planning and scheduling requires the project to be broken down into smaller, more manageable activities. Each of the activities is defined and characterized by a unique set of information. The basic information that defines an activity are its identification number, description and duration.

Note: It is easiest if the Activity ID, Description, Duration, Calendar and Coding are all entered in P3 one activity at a time. The steps to enter this data will appear after all these data items are discussed. Also note that any of this information, except for Activity ID, may be easily changed after it is entered. Simply highlight the activity with the *Activity Form* open, edit the desired field, and click **OK** to save the edits.

Identification (ID) Number

An ID number is a unique set of alphanumeric characters which distinguishes one activity from another. Schedulers may use a system to number the activities which allows for better organization of the activities. An example of an intelligent activity ID structure used on a construction project is presented on the following page.

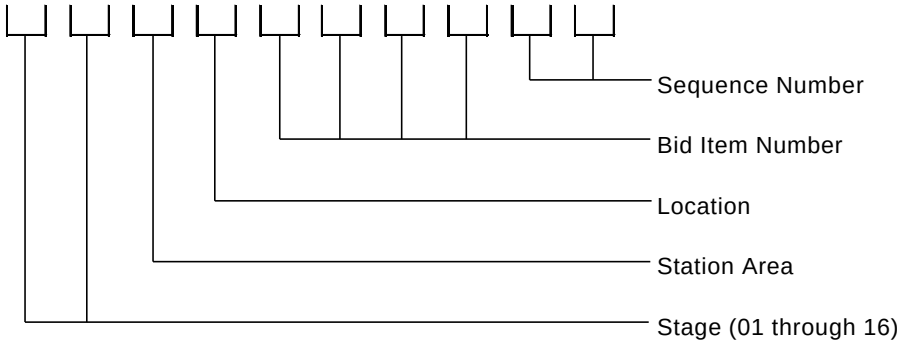
It is important to note that Primavera has an option to automatically number activity IDs as new activities are entered. To use an intelligent activity ID structure like the example, the automatic numbering feature must be disabled. To disable this feature or to verify that this feature is disabled, follow these steps:

- Click **Tools**, **Options**, **Activity Inserting**
- If there is a check mark next to *Automatically number activities*, this feature is enabled. Click the check box until the check mark disappears. Click **OK**.

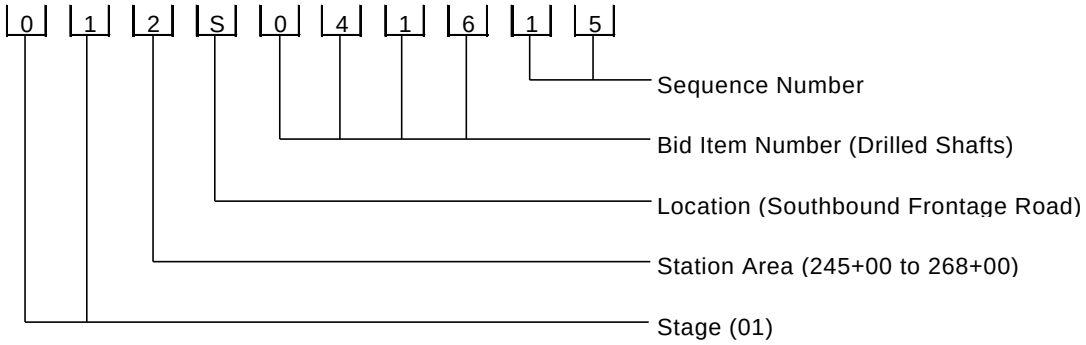
Activity ID Structure

North Central Expressway, US 75(M) Project

10 Digit Activity ID Explanation



Example Activity ID



Location

- B - Southwest
- C - Caruth Haven
- L - Loop 12/Northwest Highway
- M - North Park
- P - Park Lane
- W - Walnut Hill
- S - Southbound Frontage Road
- N - Northbound Frontage Road
- I - Inbound Main Lanes
- O - Outbound Main Lanes
- R - Ramp

Station Area

- 1 - Whole Project
- 2 - 245+00 to 268+00
- 3 - 268+00 to 281+00
- 4 - 281+00 to 298+00
- 5 - 298+00 to 321+00
- 6 - 321+00 to 351+00
- 7 - 351+00 to 375+00
- ? - Ramps A, B,C, etc
- E - East side cross streets
- W - West side cross streets

Description

The description of an activity should contain enough information to determine what work the activity represents. Often, work activities appear in many phases of a project. For example, when a bridge is built in staged construction, each phase may include the construction of drilled shafts, footings, bents and columns. A description of "Drilled Shafts" does not describe the work as well as "Drilled Shafts, Phase 1."

Duration

The duration is the amount of time, in working units (days), estimated to complete the work. The duration should be determined by dividing the quantity of work each activity represents by the anticipated production rate. This calculation may be done in two ways. The easiest way is to do the calculations outside of Primavera by setting up an Excel spreadsheet or by doing the calculations manually. The advanced way is to load the quantities and production rates into Primavera and allow the program to calculate the durations. This advanced approach will not be discussed in this document.

For construction projects, the maximum duration for most activities is 20 working days. This should be a target maximum for time determination schedules as well.

Assign Appropriate Calendar

If the complexity of the project warrants the use of multiple calendars, it is important to assign each activity to the appropriate calendar. Remember that P3 uses Calendar 1 as the default. If the scheduler sets up Calendar 1 as the Road Work calendar and forgets to change the calendar for bridge activities, for example, the schedule will not be accurate.

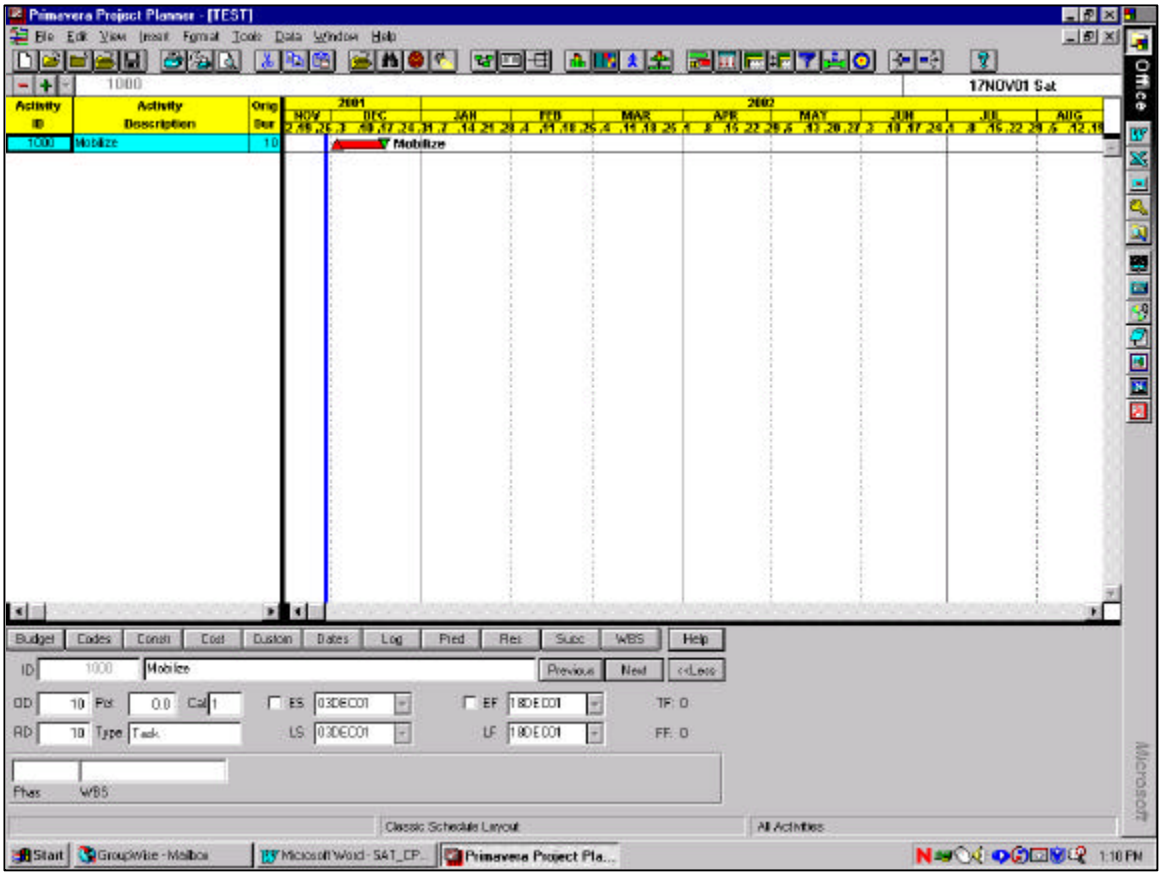
Assign Appropriate Activity Code

Multiple codes may be used for a complex project. When entering activities, it is a relatively simple task to add these codes to each activity. Primavera does not assign default codes to an activity.

To enter Basic Activity Information including Activity ID, Description, Duration, Calendar ID and Activity Codes, follow these steps.

- Close all open windows, if any, left open from previous steps.
- Click **View**, **Activity Form**.
- Click the + button at the top left of the screen. A new blank activity line will appear.
- Enter the Activity ID and click the ✓ button.
- In the open *Activity Form* at the bottom of the screen, click in the *Description* field and type the activity description.

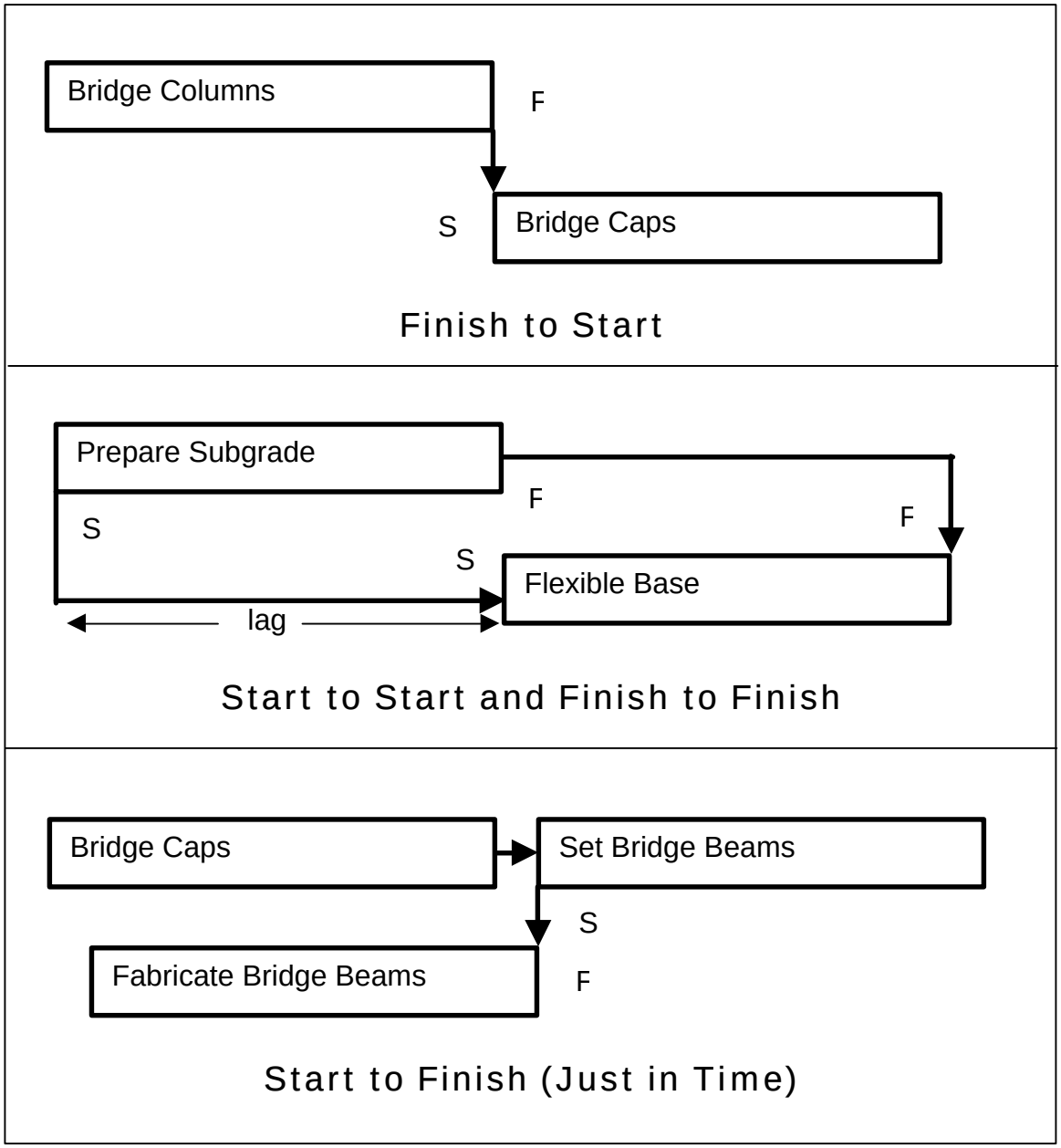
- Click on the *OD* (Original Duration) box or use the Tab key to move the cursor to the *OD* box. Enter the duration calculated earlier in this field.
- Click on the *Cal* (Calendar) box or use the Tab key. Select the appropriate calendar using the pick list button (▼).
- Click on the code fields at the bottom of the screen. The code structure created in Step 4 will appear here. Use the pick list button (▼) to select the appropriate code or codes for the activity.
- For most activities and most schedules, accept the P3 defaults for the remaining fields. Click the **OK** button.
- Repeat these steps for all the activities to be entered.



It is of utmost importance to leave the *Pct* field (Percent Complete) alone at this time. It is also important to leave the *ES* (Early Start) and *EF* (Early Finish) date boxes alone. Primavera will calculate these in a later step.

Step 6. Add Relationships

Relationships model the order in which activities can be done given the physical, resource and contractual constraints. There are four possible relationships, however the first three shown below are used almost exclusively. The one relationship that is rarely used is the start to finish. Very few situations warrant the use of the start to finish relationship.



By far, the most difficult part of CPM scheduling is the translation of the physical relationships between work tasks on the construction project to logical ties between schedule activities. The following discussion may help the scheduler get started with this translation.

As seen in the example on the previous page, bridge work commonly uses the finish-to-start relationship type. In other words, one activity must **finish** before the next activity can **start**. In the example, the bridge columns must be complete before the caps can start.

This is a good time to introduce the concepts of predecessors and successors. In the bridge work example, the Bridge Columns are *predecessors* to the Bridge Caps. In this same example, the Bridge Caps are *successors* to Bridge Columns.

Road work typically uses start-to-start in tandem with finish-to-finish relationships. In the example on the previous page, the flexible base can start after the subgrade preparations have started and have progressed for a while (using *Lag* time to specify the amount of time an activity must be active before the successor can start). It is not necessary to have finished the subgrade preparations before starting the base work. However, before the flex base can be finished, the subgrade preparations must be finished. Almost all CPM schedules can be created using nothing but these three types of relationships.

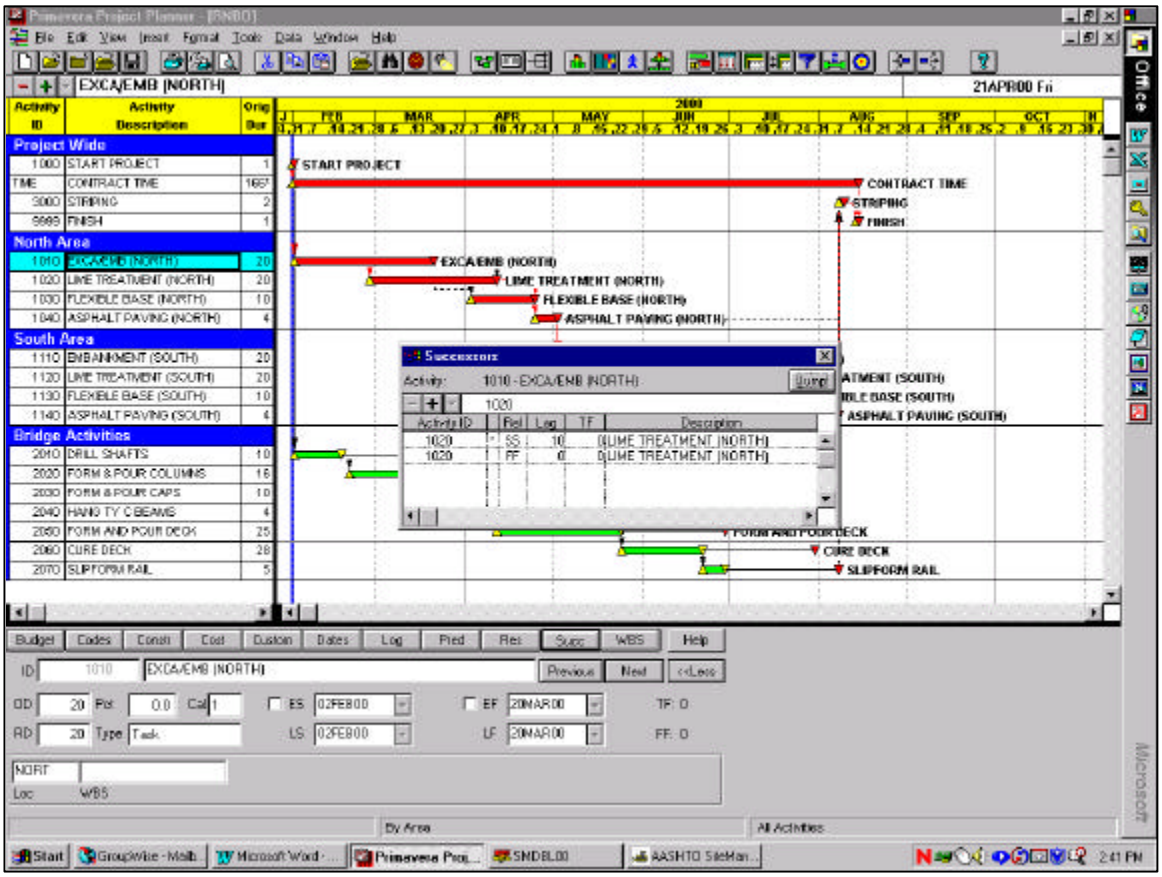
Some schedulers prefer to build the schedule relationships by looking at predecessors only. In other words, they decide what work must be done before the activity they are concerned with starts. Some schedulers feel more comfortable looking at successor relationships. They like to think of what can be done now that this particular activity is complete. Whichever approach is preferred, it is recommended to stick with one approach only. Changing the way schedule logic is built mid-stream increases the odds that mistakes or omissions will result.

Another key concept is that all activities in the schedule, except for the starting activity, must have at least one predecessor. All the activities in the schedule, except for the completing activity, should have at least one successor. Any given activity can have many predecessors and many successors.

There are several ways to add relationships in Primavera. However, only one will be presented at this time. To add **successor** relationships in Primavera, follow these steps:

- With the *Activity Form* open (click **View**, **Activity Form** if it is not open already), click and highlight the desired activity.
- In the *Activity Form*, click the **Succ** button (Successors). This opens the *Successor* window.

- In the *Successor* window, click the + button to add a successor.
- Click the pick list button (▼) to display a complete listing of all activities in the schedule. Scroll through the list until the desired activity is located. Click the desired activity to add it as a successor.
- Note that P3 chooses FS (finish-to-start) as the default relationship type. If other than FS is desired, click the *Rel* column (relationship type) and use the pick list to change the type of relationship.
- If the scheduler wants to set up the SS and FF relationships in tandem, **both** relationships must be added. First, click the + button to add a successor. Click the pick list button (▼) and scroll through the list until the desired activity is located. Click the desired activity to add it as a successor. Change the relationship type to SS. Highlight the *Lag* column and change this to the desired value. Click the + button to add another successor. Click the pick list button (▼) and find the same successor. Change the relationship type to FF. Enter a lag if desired. When complete, the successor window will look like the following example.



- Repeat these steps for each activity until all the relationships have been added.

Step 7. Run The Schedule Calculations And Trouble-Shoot

Before additional steps are taken, it is very important to ensure that the critical path has been properly defined. This is one area where an experienced and deceitful scheduler can manipulate the schedule to hide the critical path or to falsely show activities as critical.

There are two classic definitions of "critical path." First, one can define the critical path as those activities on the longest path through the network. The critical path can also be defined as those activities having the least float. Of these two definitions, **only the longest path definition will show the true critical path every time.**

To check the definition of critical path, follow these steps:

- Click **Tools**, **Options**, **Critical Activities**
- Click the radio dial (⊙) next to Longest Path, and click **OK**.

There are two ways to calculate the schedule in Primavera. The recommended method provides valuable scheduling statistics when the calculations are complete. To calculate the schedule in this manner, follow these steps:

- Click **Tools**, **Schedule**
- For an original schedule, the *Data Date* should be the expected start date of the project. When doing a time determination schedule, the scheduler may assume that the project will start two or three months after the letting date. To change the *Data Date*, click the pick list button (▼) and scroll through the calendar to the desired date.
- It is good scheduling practice to request *Constraints*, *Open Ends* and *Activities with out of sequence progress* in the scheduling report. Make sure an "x" appears to the left of these items.
- For basic scheduling, accept the Primavera defaults for Options.
- Click **Schedule Now**.
- Select *View on Screen* by selecting the appropriate radio dial (⊙) and click **OK**.
- P3 will complete the calculations and send the output to a companion program called "Primavera Look"
- Scroll through the output (discussion of the output is provided below).
- If a printout is desired, remove page breaks by placing the cursor to the far left just above each break (usually a dotted red line). Hit enter and then backspace. Repeat for each break. Print the output.
- Exit Primavera Look (not P3) by clicking **File**, **Exit**.
- P3 will prompt the user. Choose **No** (clicking Yes will save the output only) to return to the main P3 program.

If a "loop" in the logic exists, P3 will issue a warning message and produce a report showing the loop in the logic. Loops must be eliminated before the scheduling calculations can be completed.

P3 Schedule Calculations Output by Page

Page 1 provides general information regarding the schedule. Page 2 displays information regarding constraints, if any. Page 3 provides a listing of open-ended activities (those without predecessors and/or successors). As a minimum, each schedule will have one activity (the project start) with no predecessors and one activity (project completion) with no successors. Page 4 will display activities with out-of-sequence progress (for an original schedule, there should be no progress and certainly no out-of-sequence progress). The last page will provide scheduling statistics.

For an original schedule, the important information to note includes the number of activities and the number of activities in the longest path (critical path). Typically, one-third of the activities in original schedules are critical. It is important to note the number of relationships. Schedules with sound logic typically have more relationships than activities. However, if the number of relationships outnumbers the number of activities by a wide margin, the schedule might be overly restricted.

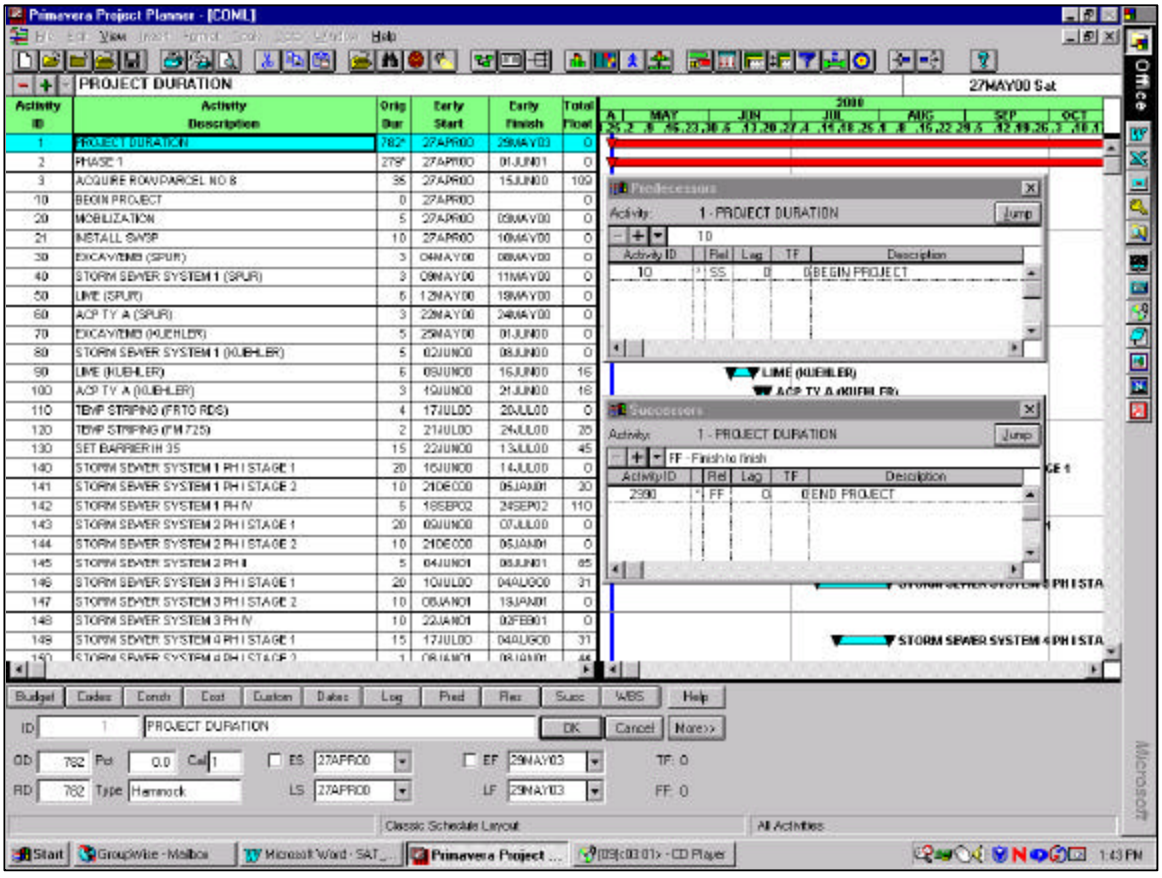
After getting the schedule logic as desired, add an activity called "Time Calculator." This activity may be added by following these steps:

- With the schedule organized by Phase, highlight the first activity and press the **Insert** key or click the plus button (+).
- P3 responds by adding a blank line to add an activity. At the bottom of the screen, a blank Activity Form may appear. If not, click **View**, **Activity Form**.
- Type an activity ID number and an activity description similar to "Contract Time Calculator" in the spaces provided. P3 may automatically assign an activity ID number. To disable this feature, click **Tools**, **Options**, **Activity Inserting**, and remove the "x" from the Automatically Number Activities box.
- Change the type of activity to "Hammock"
- Change the calendar to that one that models how contract time will be charged.
- Find the activity that coincides with the beginning of time charges. Add this activity to the hammock as a predecessor. To do this, open the predecessor window by clicking the **Pred** button, click the plus button (+), click the pick list button (▼), scroll through the list of activities, highlight the time start activity, and change the relationship type to SS.
- Click **OK**, close the Predecessor window.
- Add the last activity in the schedule to the hammock as a successor. Open the successor window by clicking the **Succ** button, click the plus button (+),

click the pick list button (▼), scroll through the list of activities, highlight the last activity, and change the relationship type to FF.

- Click **OK**, close the Successor window.
- Recalculate the schedule. Exit Primavera Look.
- Find the hammock activity. Note the original duration – this is the number of working days that will be required to complete the project. Also note the number of months required – this is the number of months of Item 502, Barricades to set up.

When correctly added, the time calculator activity will look like the example on below.

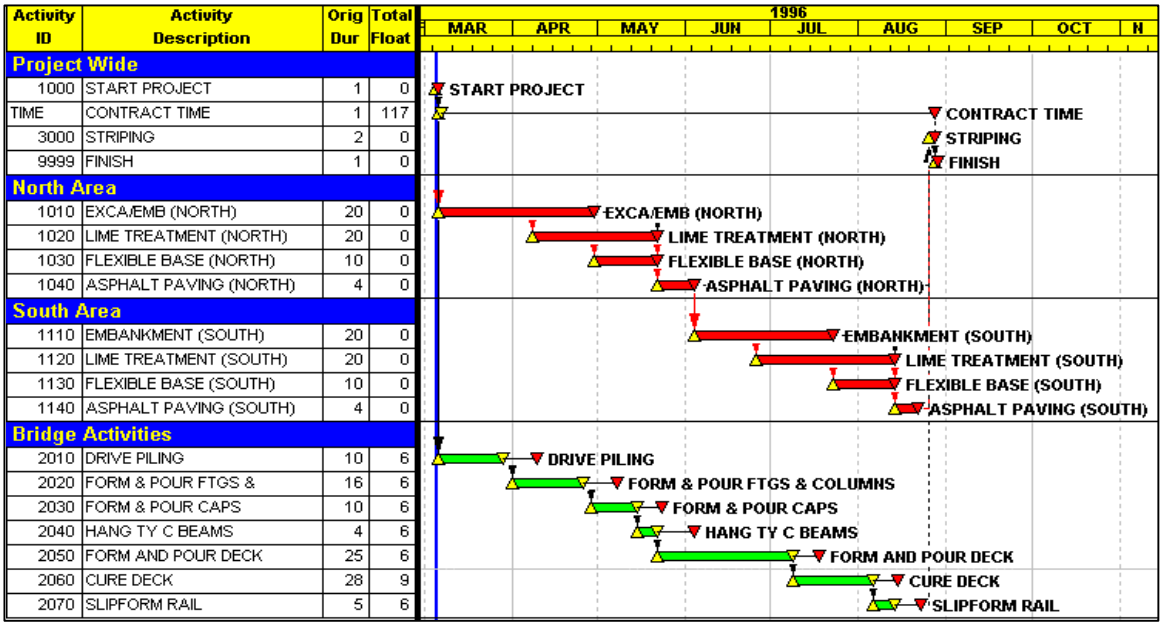


After calculating the schedule, it may be decided that the time frame is excessive and needs to be compressed. This practice is known as "crashing the schedule." If the schedule must be crashed, the scheduler may:

- Decrease durations of critical activities. If the schedule is properly resource-loaded, this can be as easy as simply revising the expected productivity rates. This, in turn, reduces the duration.
- Revise the logic.

Consider the schedule in Figure 2 below:

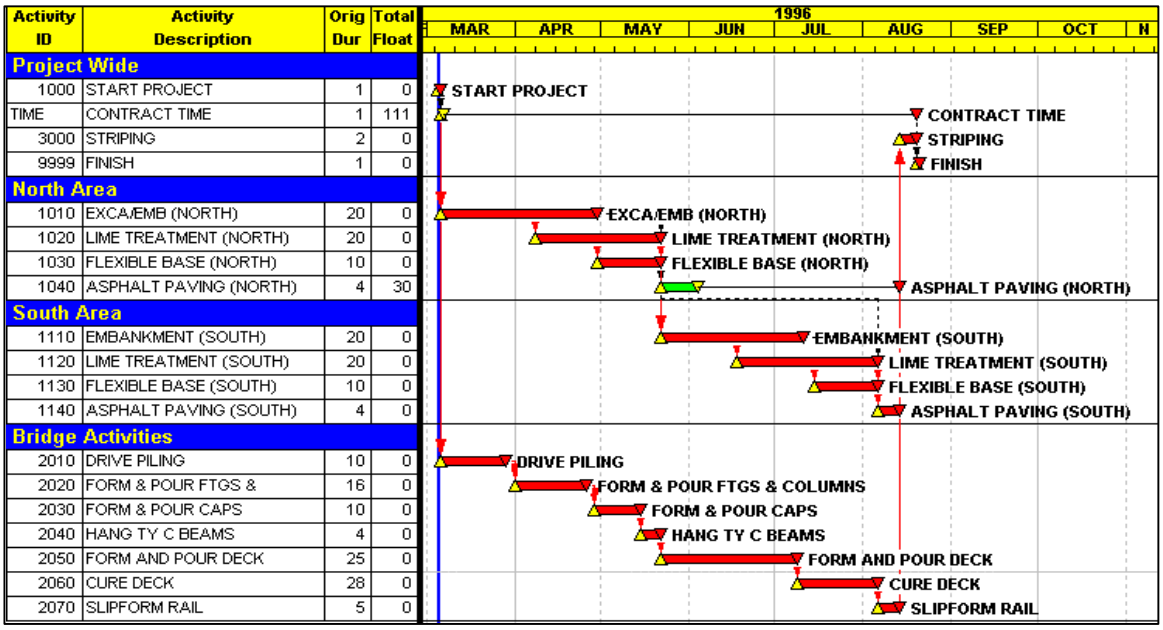
Figure 2
Schedule Crashing Example



Activity ID	Activity Description	Orig Dur	Total Float
Project Wide			
1000	START PROJECT	1	0
TIME	CONTRACT TIME	1	117
3000	STRIPING	2	0
9999	FINISH	1	0
North Area			
1010	EXCA/EMB (NORTH)	20	0
1020	LIME TREATMENT (NORTH)	20	0
1030	FLEXIBLE BASE (NORTH)	10	0
1040	ASPHALT PAVING (NORTH)	4	0
South Area			
1110	EMBANKMENT (SOUTH)	20	0
1120	LIME TREATMENT (SOUTH)	20	0
1130	FLEXIBLE BASE (SOUTH)	10	0
1140	ASPHALT PAVING (SOUTH)	4	0
Bridge Activities			
2010	DRIVE PILING	10	6
2020	FORM & POUR FTGS &	16	6
2030	FORM & POUR CAPS	10	6
2040	HANG TY C BEAMS	4	6
2050	FORM AND POUR DECK	25	6
2060	CURE DECK	28	9
2070	SLIPFORM RAIL	5	6

If the scheduler wanted to compress this project, there would be no benefit to reduce the duration of bridge work – these activities have float. Compressing the chain of roadwork activities would be the logical choice. Assume for a moment that the durations of these activities already assume maximum productivity rates. How can the schedule be compressed by revising logic without increasing cost? The answer lies in the most efficient use of the Contractor's crews. Assuming that Crew One is assigned to construct the excavation/embankment, lime treatment and flexible base and Crew Two is assigned to construct the asphalt paving. The project may be resequenced as shown in Figure 3 (following page) without increasing the project cost. In fact, the more efficient use of these crews would probably save the Contractor money.

Figure 3
Crashed Schedule – Step 1



Activity ID	Activity Description	Orig Dur	Total Float
Project Wide			
1000	START PROJECT	1	0
TIME	CONTRACT TIME	1	111
3000	STRIPING	2	0
9999	FINISH	1	0
North Area			
1010	EXCA/EMB (NORTH)	20	0
1020	LIME TREATMENT (NORTH)	20	0
1030	FLEXIBLE BASE (NORTH)	10	0
1040	ASPHALT PAVING (NORTH)	4	30
South Area			
1110	EMBANKMENT (SOUTH)	20	0
1120	LIME TREATMENT (SOUTH)	20	0
1130	FLEXIBLE BASE (SOUTH)	10	0
1140	ASPHALT PAVING (SOUTH)	4	0
Bridge Activities			
2010	DRIVE PILING	10	0
2020	FORM & POUR FTGS &	16	0
2030	FORM & POUR CAPS	10	0
2040	HANG TY C BEAMS	4	0
2050	FORM AND POUR DECK	25	0
2060	CURE DECK	28	0
2070	SLIPFORM RAIL	5	0

Compare this logic to Figure 2. In Figure 2, Activity 1040 was a predecessor (FS) of Activity 1110. In other words, all the road work on the North Area had to be completed before the South Area could start. Under the original scenario, Crew One would wait around for four working days while Crew Two paved the North Area.

Now, in Figure 3, the road work in the South Area starts before the North Area is complete. Crew One would complete the flex base in the North Area then start immediately on the South Area embankment. This lack of down-time would save the Contractor money.

If additional crashing of the schedule was needed, the road work and the bridge work would both have to be compressed. Note that in Figure 3, both these chains of activities are critical (zero float).

To prepare plots and prints of the completed time determination schedule, please refer to Chapter 2, Step 10, Page 2-20.

Chapter 2
Review Process For Original Schedules
(Computer Monitoring Of CPM Schedules)

Overview and Roles

The review and acceptance of Contractor's schedules for construction projects involves the department's project administration reviewing the schedule for:

- Compliance with the project scheduling specification in regard to content and form.
- Compliance with the contract sequence of work and/or traffic control plans.
- Inclusion of all work in the schedule.
- The schedule showing the work being completed within the allowable number of working days.
- Major scheduling blunders.
- Production rates.

The goal of this effort is for the Contractor and the department to agree on a schedule. The accepted schedule should not be revised without agreement from both parties.

Contractor Role:

The Contractor's role is to create the schedule then to provide it to the Department with adequate time for review before beginning work.

Department Role:

The department's role is to review the schedule in a timely manner, point out any problems found in the schedule to the Contractor, then provide written acceptance. The department may require that a specific Critical Path Method (CPM) computer program (generally Primavera Project Planner or SureTrak) be used to facilitate the department's review and monitoring of the schedule. The reason for requiring a specific program is that there are so many programs on the market that it is not practical for department personnel to have a copy of each and know how to use it. It is essential to facilitate reviewing and monitoring of the schedule to use the computer program the schedule was developed on.

Keep in mind that it is the Contractor's schedule. **TxDOT cannot have any ownership in the schedule**. If a problem is detected with the schedule, it is the Contractor's responsibility to correct the problem, not TxDOT's.

Note that the scheduling specification requires the Contractor to submit an acceptable schedule **before starting work**.

Preliminary Activities

Before starting to review a CPM schedule submitted for a construction project, some preliminary information is needed. From the PS&E, determine the following:

- The level of scheduling required (special provision to Item 8).
- If Primavera is required or if SureTrak is allowed.
- The number of working days allowed.
- The number of months of barricades allowed.

Next, obtain a copy of the CPM Schedule Review Checklist for Original Schedules (included in Appendix A). Enter project ID information on form. This form will serve as a checklist for the schedule review and will document the findings of the review. During each step in the review, record information and schedule review findings on this form.

Next, scan the floppy disk for viruses. If a virus is detected, remove the floppy disk from the drive, notify district Information Systems personnel, and request the Contractor to provide a new disk. If the diskette is clean, proceed with the analysis.

Create a directory or folder for each new project. It is suggested that a separate directory or folder be created for each construction contract or project. Keep the original schedule and all future revisions and updates in this folder or directory. This will enhance file management ability and allow the comparison of future schedule updates to the original or other updated schedules. For large, lengthy projects, additional file management and data storage considerations may be warranted.

Schedule Review

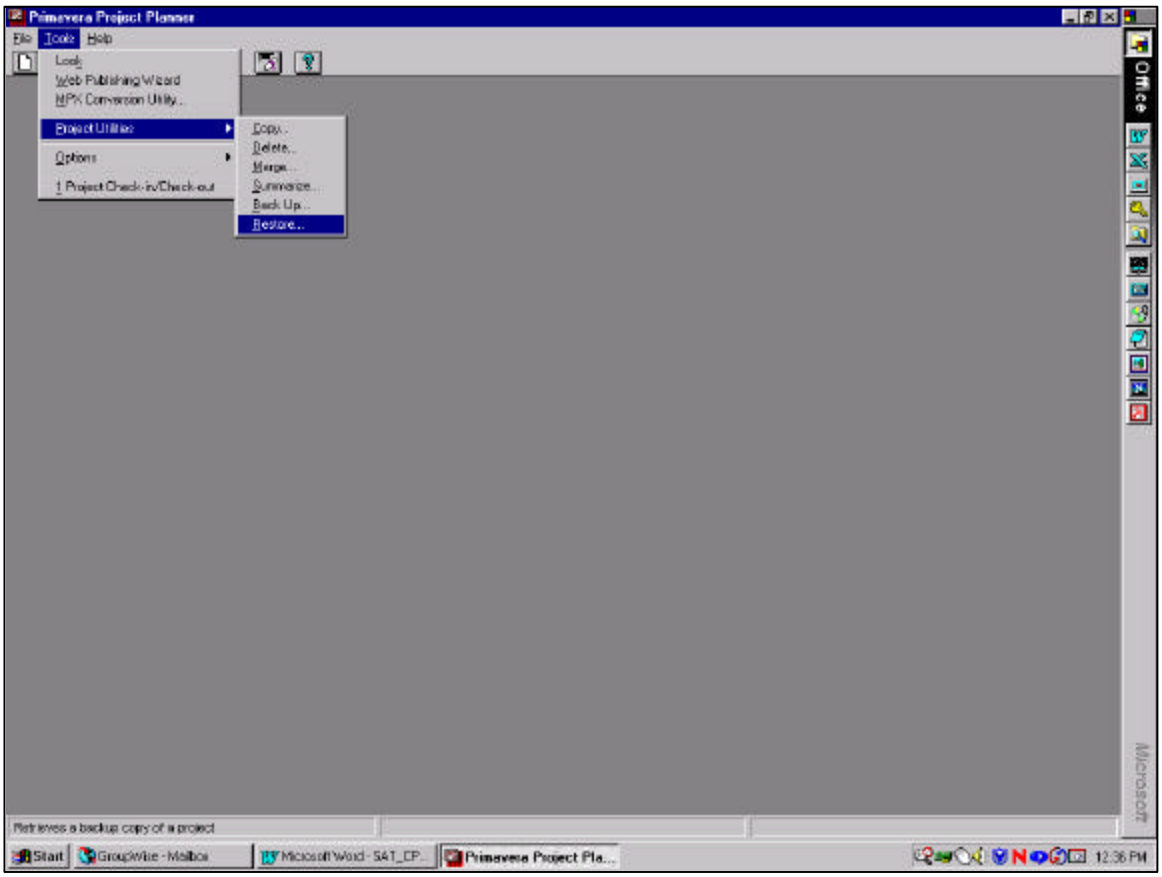
The following steps are necessary to review a schedule for compliance with the CPM special provisions. All of the steps are necessary for a comprehensive review. The steps do not necessarily need to be taken in the exact order as presented below. However, following the prescribed order may prevent rework.

Step 1. Restore The Schedule

Primavera uses the term “restore” for transferring a schedule from a floppy disk to the network or local hard drive. The following steps are involved:

- Click **Tools**, **Project Utilities**, **Restore**
- In the *From* portion of the window, locate the desired project on the floppy drive. Double click the box to the left of the schedule name so that a check mark appears.

- In the *To* portion of the window, change the directory to the newly created drive and directory, click the boxes to the left of the *Restore Tabular Reports* and *Restore External Relationships* so that "x" appears.
- Click **Restore**, **OK**.
- After restoration is complete, click **OK**.

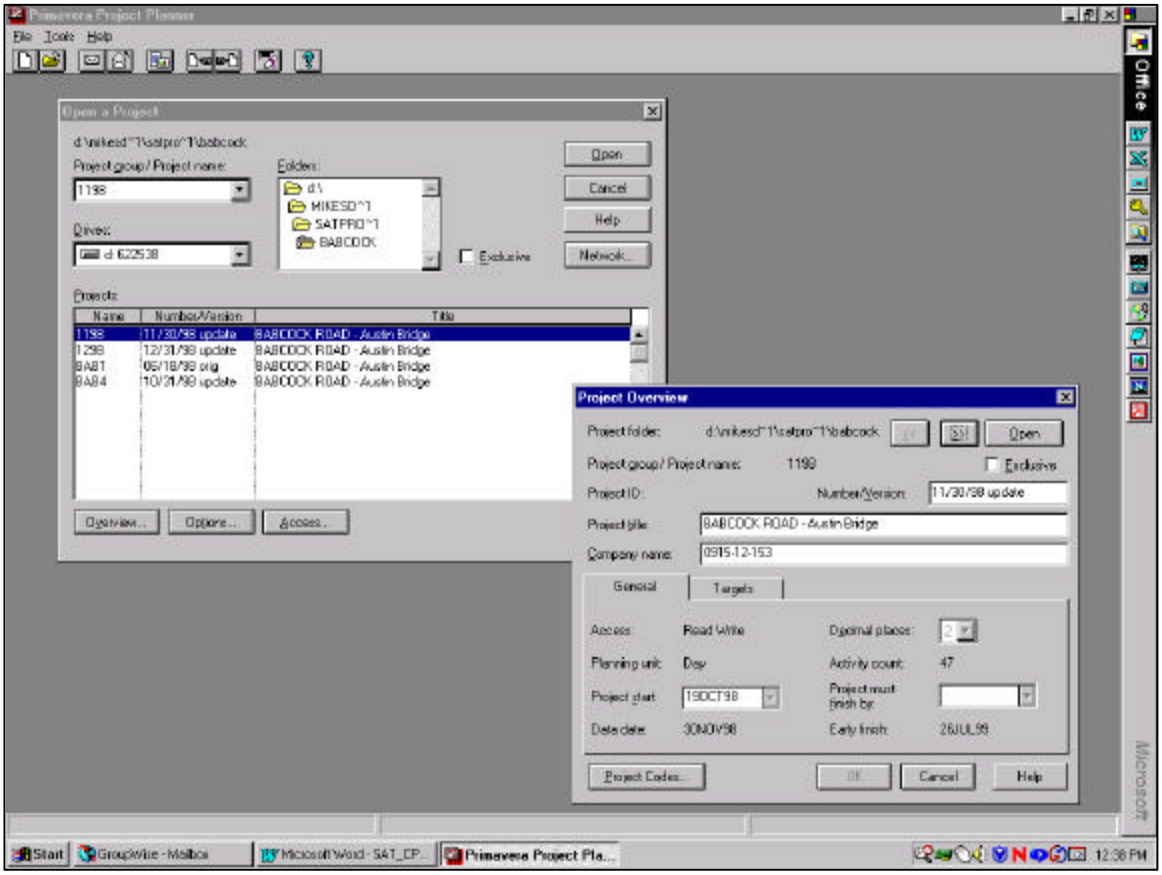


Step 2. Open The File

Open the desired file. It is important to note that P3 saves data as it is added, deleted, and/or changed, and that there is no "undo" command.

- Click **File**, **Open**. Locate newly restored project. The drive and directory may need to be changed.
- Highlight the desired project and click the **Overview** button.
- In the Overview window, look for an imposed finish date. Remove if this date is earlier than the calculated early finish date. Negative float is created if the imposed finish date is earlier than the calculated early finish date.

- Click **Open**.



In this example, there is no imposed finish date. If one were imposed, the date would appear in the *Project must finish by* box in the *Project Overview* screen.

Step 3. Review The Calendars

Calendars are used to account for non-work periods including holidays, weekends, and assumed bad weather days.

Holidays

Certain holidays are mandatory non-work days specified in the contract. In addition, the Contractor may not be planning to work on other holidays or the days before and after holidays.

Work Week

A work week is defined by the Contractor's decision to work Saturdays and/or Sundays. A work week may be five, six, or seven days per week.

Bad Weather Days

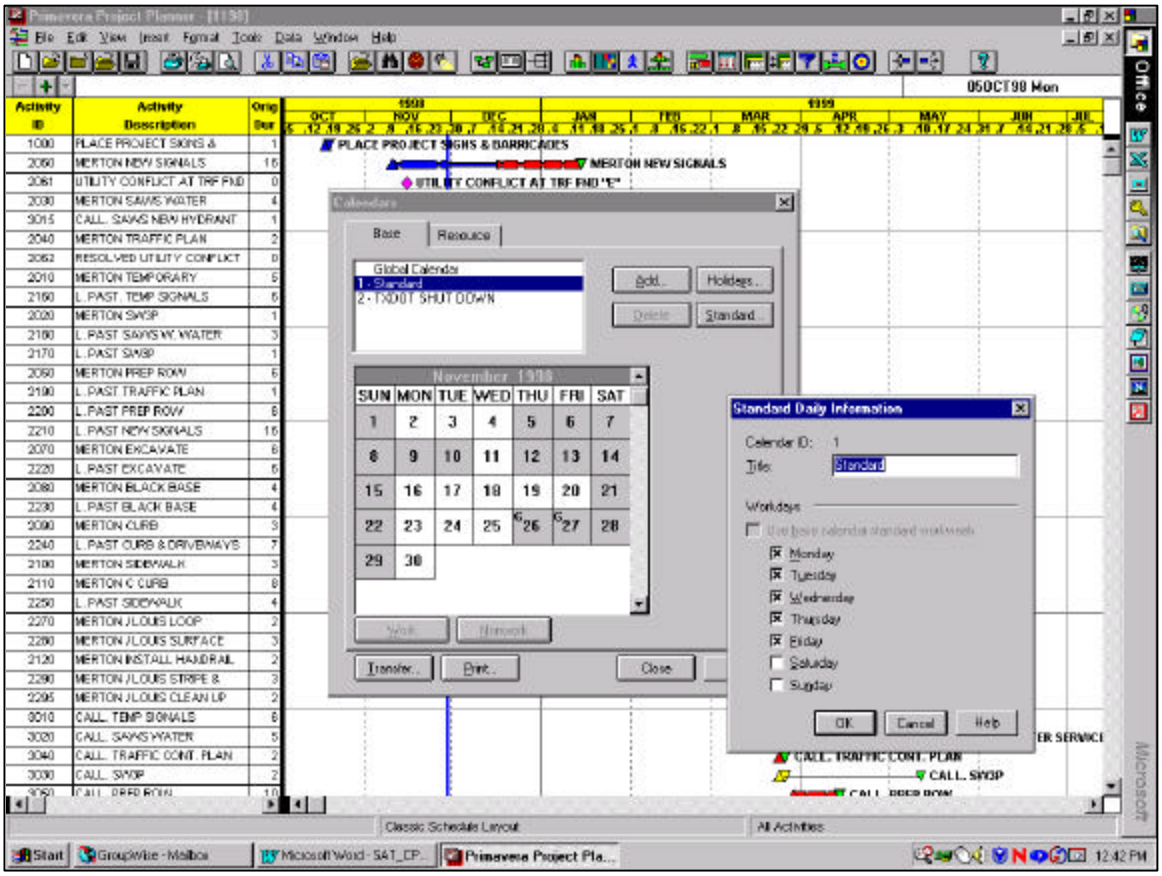
Days lost to rain, snow, site being too wet, etc. can be estimated by looking at historical weather data and accounted for in the calendars as non-work days. Some schedulers consider the impact of weather within the activity durations. **This is not recommended because the effects of weather cannot be isolated.**

Typical Construction Calendars

0 Global calendar: includes holidays only. Non-work days and holidays in the global calendar will show up in all other calendars.
1 Dirt work calendar: includes rain days and too wet days.
2 Bridge work calendar: includes rain days only.
3 Curing calendar: 7 days/week.
4 Asphalt calendar: models asphalt season.
5 Mall calendar: no work during holidays around the mall.
6 Seeding calendar: considers growing seasons.
7 Contract time calendar: models how time will be administered.

To review the calendars, follow these steps:

- Click **Data**, **Calendars**
- Highlight the global calendar. Click the **Holidays** button. Make sure **that at least the six major holidays** are identified as non-work days. If these holidays are not marked out as non-work days in the global calendar, you may need to check each calendar individually for holidays.
- Review each of the remaining calendars.
- Print copies of calendars for future reference. Select the **Detailed** option. P3 will default to print calendars for the entire duration of the project.
- If curing time is a major consideration, make sure a curing calendar has been created and that no holidays or non-work days are identified. Remember, concrete cures seven days a week, 52 weeks a year.
- Evaluate the calendars for consideration of weather. If a calendar shows six or seven working days per week (even on calendar day projects), the Contractor is probably overly optimistic. Weather, traffic and other factors will most likely limit the Contractor to five working days per week or less.
- If the project includes several types of work (for example, bridge and roadway work), there should be separate calendars set up.
- If multiple calendars are used, check to see if activities and calendars are properly associated. An easy way to do this is to organize the schedule by calendar ID (see Step 7 for hints on schedule organization).



In this example, the Contractor is showing the normal work week to be five days per week as seen in the *Standard Daily Information* box. Note that November 26 and 27 are shown grayed out. These days are non-work days for Thanksgiving. The "G" in these two boxes stands for "Global," and means these two days will appear in all calendars as non-work days.

Step 4. Review Activity Coding Structure

Activity coding is perhaps the most important, yet most commonly ignored, aspect of a useable large schedule. A good coding structure is essential for grouping activities for reporting and plotting purposes. The lack of comprehensive activity coding in CPM schedules can be one of the biggest setbacks to getting the full benefit of the schedule. There are many cases where project personnel have given up and abandoned the schedule because the networks resemble electrical wiring diagrams and were impossible to understand.

Many individuals must collaborate to complete a project. Each individual has different information needs. For instance, administrative personnel may need to have just a broad overview of the project. Project phase coding can generally meet this need. Project managers may need more detail that can be provided by Phase and Area coding or Area and Location coding used together.

Subcontractors need to know how they fit into the overall picture and how much flexibility they have in scheduling their work. Coding subcontracted work by the subcontractors' names is very helpful. The asphalt paving foreman and inspectors are more interested in when the paving work is scheduled. The work type or work item coding would be used to generate the information for foreman and inspectors. The work type and work item coding is also useful for project managers to more effectively manage resources. The following table provides examples of typical coding for construction projects.

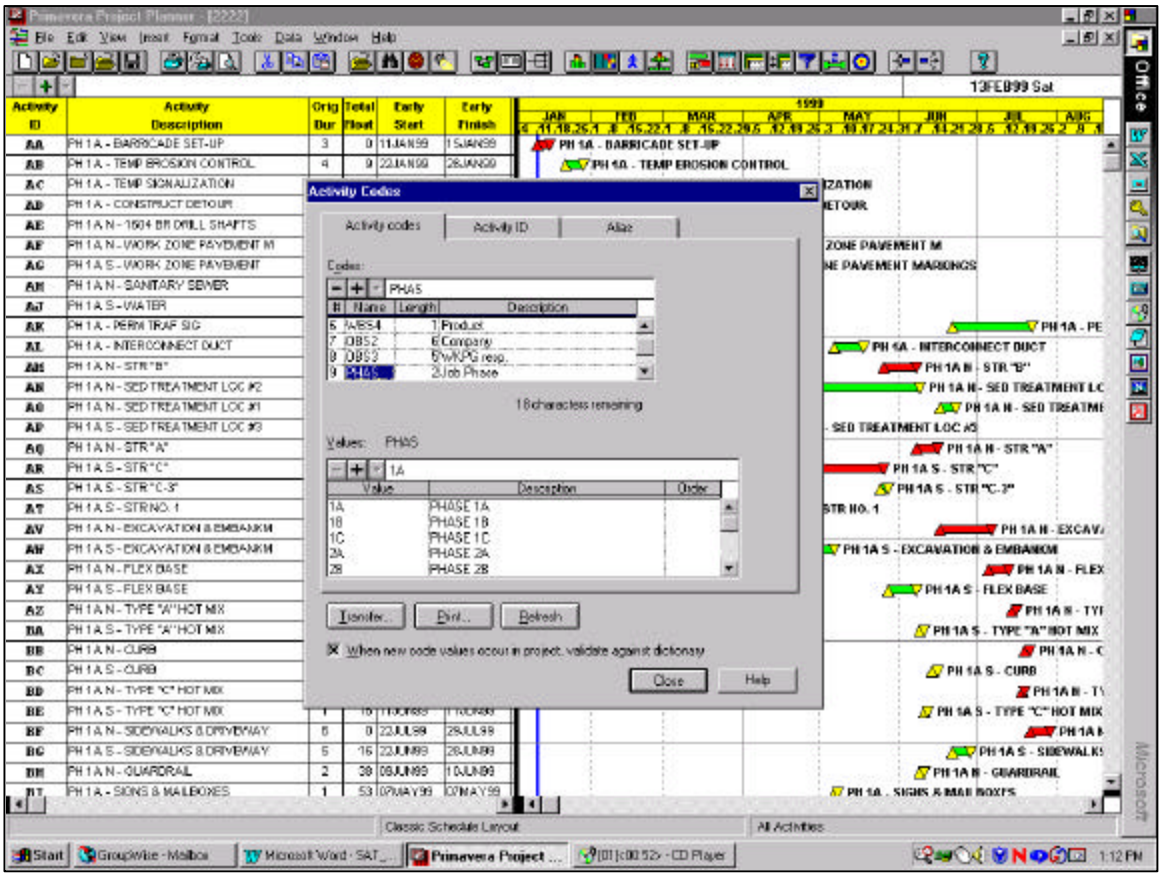
Examples of Activity Coding for Construction Projects

Code	Values	Description	Sequence
Phase	1	Phase 1	1
	2a	Phase 2a	2
	2b	Phase 2b	3
Area	LFR	Left Frontage Road	1
	RFR	Right Frontage Road	2
	RML	Right Mainlane	3
	LML	Left Mainlane	4
Location	INT1	Specific Intersection	
	RAM1	Specific Ramp	
	STR1	Specific Structure	
	STAX	Roadway Station to Station	
Responsibility	CONT	Prime Contractor	1
	SUB1	Subcontractor	2
	SUP1	Supplier	3
	DOT	TxDOT	4
Work Type	PROJ	Project Wide	1
	SDRN	Storm Sewers	3
	UTIL	Utilities	2
	EXCA	Excavation and Embankment	4
	LTS	Lime Treat Subgrade	5
	BASE	Base	6
	PAVE	Paving	7
	STR1	Bridge Structure Nos	9
Work Item	100	Prep ROW	
	110	Excavation	
	132	Embankment	
	260	Lime Stabilization	

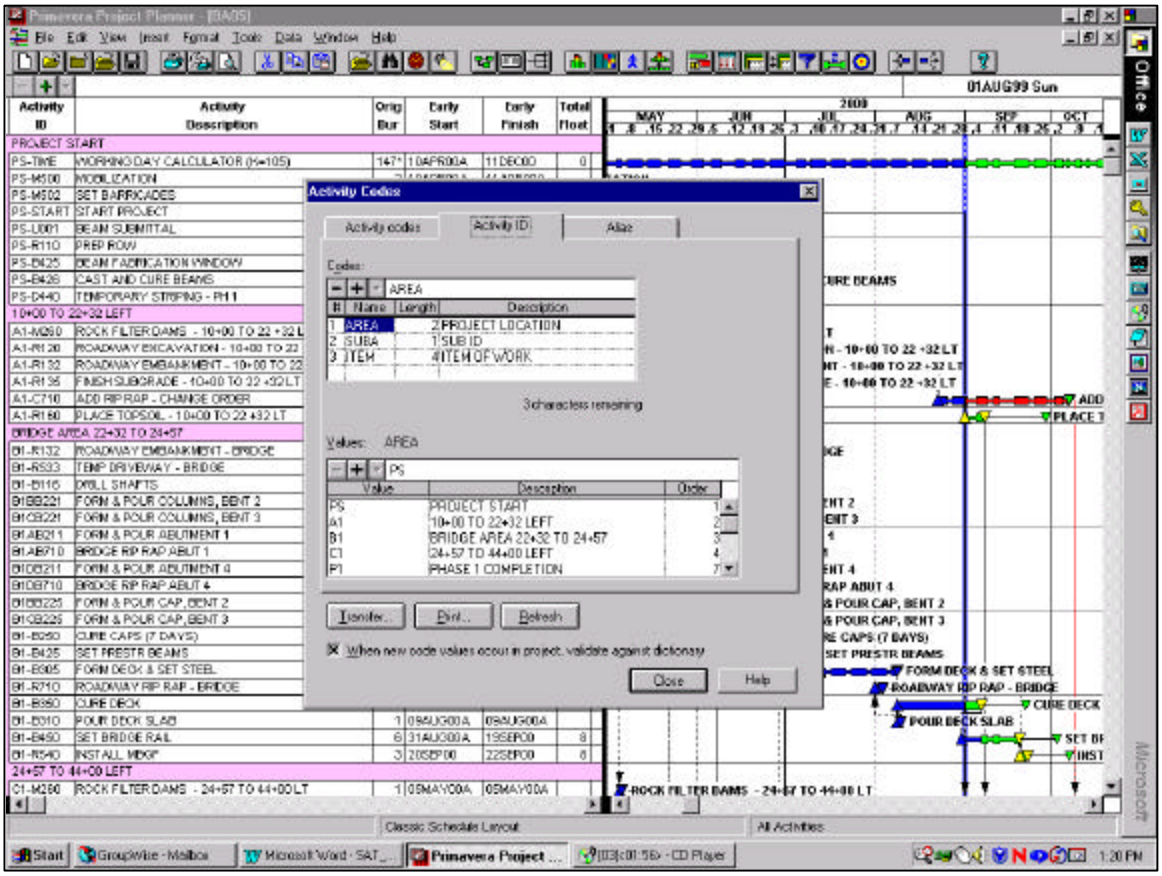
To check the coding structure, follow these steps:

- Click **Data**, **Activity Codes**

- The most common method of coding is to use Activity Codes (click the Activity Codes tab).
- In the *Codes* part of this window, one or more code classifications may be created. Highlight each code to see what values have been entered.



- Alternate methods of coding use the Activity ID or Alias features. Check to see if these features have been used, if any, by clicking on the desired tab. See the example on the following page.



In the example above, the first two digits of the Activity ID are tied to the coding structure. Once a system like this is understood, users can easily determine useful information about activities just by looking at the Activity ID.

- Once the coding structure has been determined, organize the schedule using one or more of the code structures (see Step 7 for hints on schedule organization).

Step 5. Review Resource Loading, If Required

One of the most powerful yet underutilized features of P3 is the ability to identify the resources that are planned to construct the project. Resources are defined as labor, equipment, materials, and subcontractors.

Resource loading is a critical component of a complete schedule. Keep in mind that the critical path is controlled by two factors. First, relationships define the sequence of work and therefore influence the longest path through a schedule. Second, the duration of each activity determines how long the longest chain of activities will take to complete. The duration of any activity is determined by dividing the quantity of work by the planned productivity rate. The allocation of resources to specific activities controls the productivity rate. Thus, the allocation

of resources controls the critical path. Without resources, one has no way of knowing for certain what the critical path might be.

Also consider the following scenario: A project includes construction of a bridge with eighteen bents. There are no physical constraints to prevent starting the drilled shafts for all of the bents on day one. If the schedule were prepared considering just the physical constraints, all of the drilled shafts could be started on the same day. This would require eighteen drilled shaft crews. If the Contractor only planned at the beginning of the project to bring one drilled shaft crew onto the job, the schedule would be incorrect and unrealistic. Overly optimistic and unreliable schedules result from not considering the limitations of resources.

Unfortunately, many Contractors resist the idea of loading the schedule with resources for fear that their competition might discover their secrets. Another common argument against the planning of resources is that the Contractor has unlimited resources available. For many reasons, this is a false assumption. There are economic and financial reasons, and there is the issue of overcrowding. For instance, it is easy to see why it would not be a good idea for a Contractor to plan to bring eighteen shaft drilling rigs onto a project.

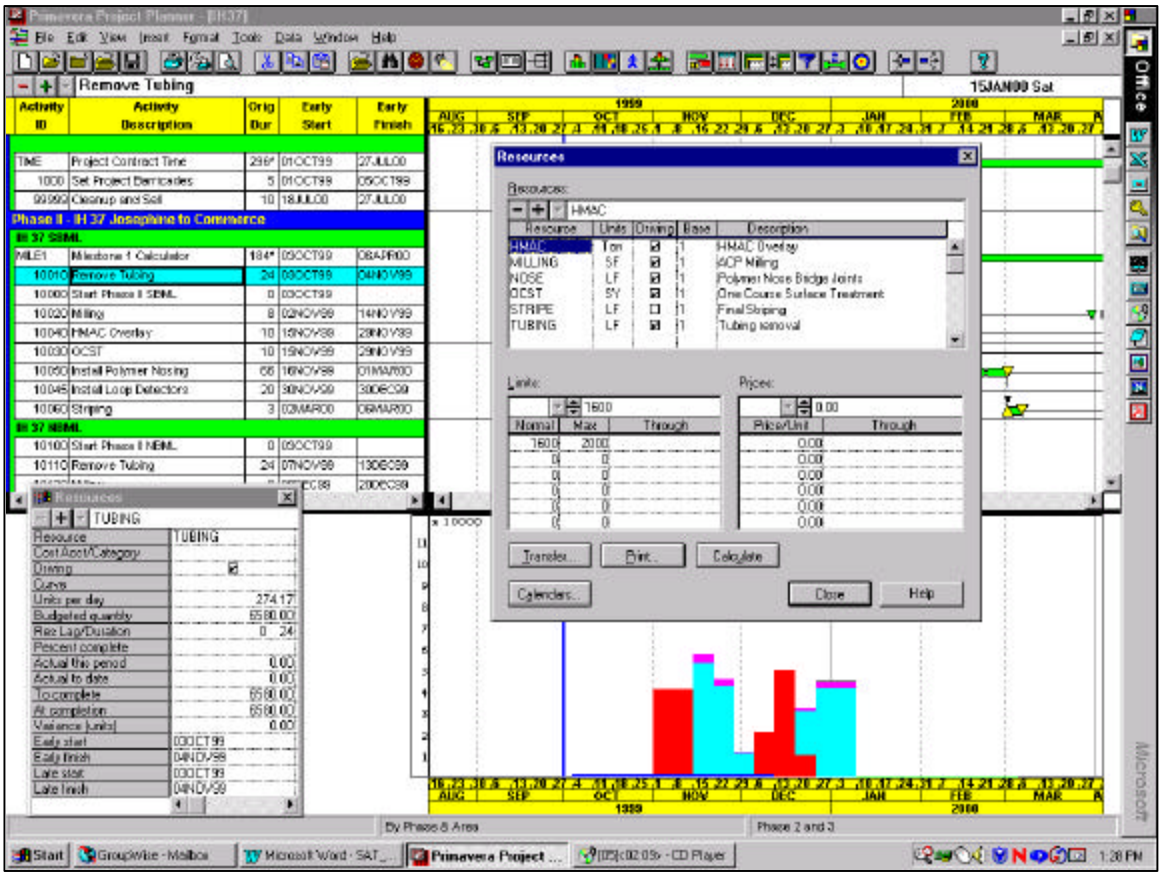
The advanced CPM scheduling specification requires the schedule to include "major resources." Major resources are defined as "crews and equipment that can constrain the Contractor from pursuing available work." TxDOT does not need to have resource loading to the level of detail where we know each hammer, nail and piece of form plywood that may be needed.

To check resource loading, follow these steps:

- Click **Data**, **Resources**
- In the *Resources* part of the window, a list of all resources that may be used on the project appears. Scroll through this list to see how comprehensively the Contractor has included resource loading.
- Highlight any resource. Look in the *Limits* part of the window. The column titled "Normal " shows the planned normal usage of that resource. The column titled "Max" shows the maximum number of that resource available.
- Look in the *Prices* part of the window. Although not required, the Contractor could use this feature to set budgets and control costs using P3.
- Close the Resources window.
- If the schedule has been resource-loaded, you must check to see if the activities have been associated with the resources. There are two ways to do this.
    1. Click **View**, **Activity Detail**, **Resources**. Scroll through the list of activities to see which resources have been associated to each activity. The *Resource detail* screen may show each actual work item to have one or more associated resource and present data in the

"Units per Day" and "Budgeted Quantity" fields. If so, the schedule probably meets the specifications.

2. Click **View**, **Resource Profile**. If the activities and resources have been properly associated, a resource histogram will appear at the bottom of the screen and the schedule probably meets the specs.



The previous example shows how Resources are defined for the entire project (the active window) and for an individual activity (the window in the lower left of the screen). The example above also shows a Resource Profile for the entire project.

Step 6. Defining The Critical Path

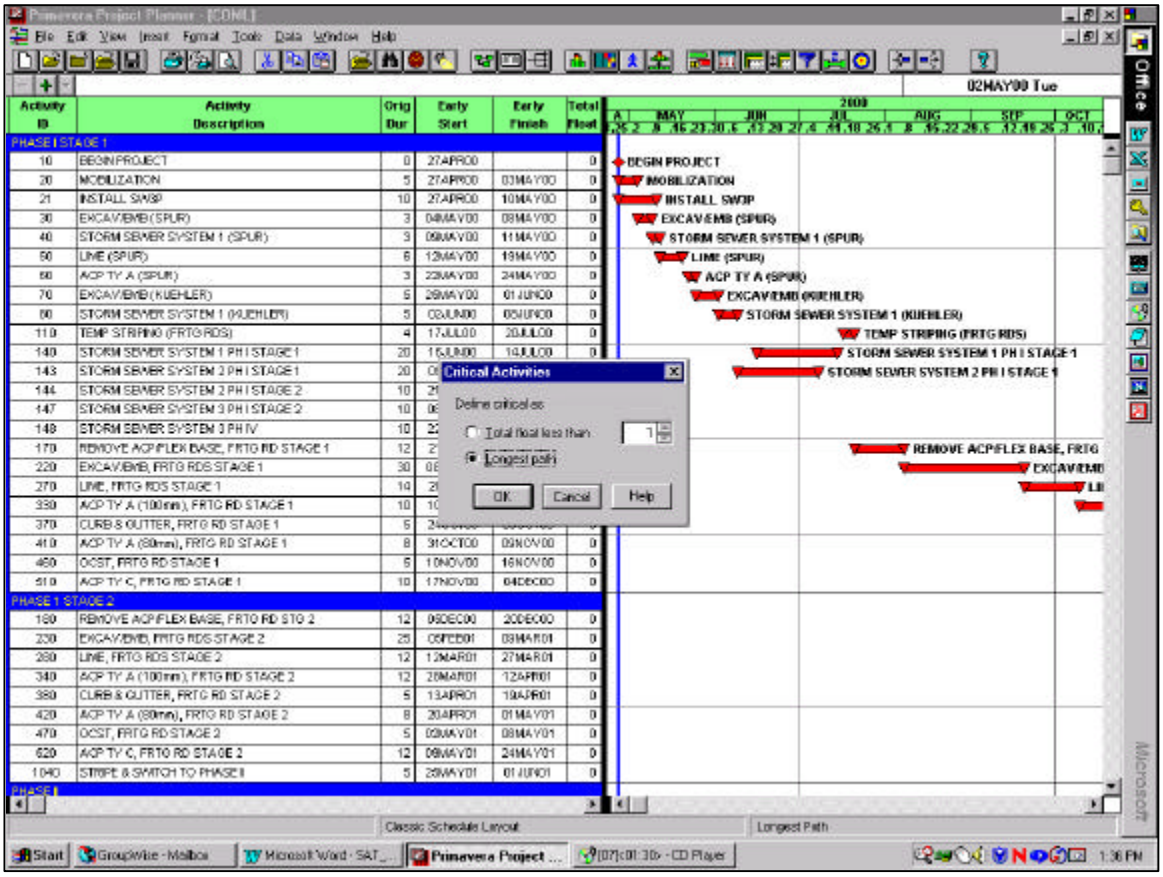
Before additional steps are taken, it is very important to ensure that the critical path has been properly defined. This is one area where an experienced and deceitful scheduler can manipulate the schedule to hide the critical path or to falsely show activities as critical.

There are two classic definitions of "critical path." First, one can define the critical path as those activities on the longest path through the network. The critical path can also be defined as those activities having the least float. Of

these two definitions, **only the longest path definition will show the true critical path every time.**

To check the definition of critical path, follow these steps:

- Click **Tools**, **Options**, **Critical Activities**
- Click the radio dial (⊙) next to Longest Path, and click **OK**.



Step 7. Organizing The Schedule (Layouts)

Unless the schedule has been saved using a layout that displays the information in a desired format, it may be necessary to organize the schedule. P3 is a large relational database capable of storing many categories of information. The schedule can therefore be filtered and sorted in a virtually unlimited number of combinations. Each of the most common methods of organizing the schedule are discussed below:

Organizing The Schedule

One of the most helpful methods of schedule organization is to organize the schedule using the coding structure. This will help show:

- If activities have been properly coded.
- If the schedule conforms to the contract sequence of work and traffic control plan.
- If there are any major scheduling blunders.
- If all contract work is included in the schedule.

To organize the schedule using the activity coding, follow these steps:

- Click **Format**, **Organize**
- In the *Organize by* part of the window, add the desired coding to create grouping. Multiple levels of grouping is allowed. To add the grouping, click the pick list button (▼), scroll through the list of available options, and select the desired data.
- In the *Sort by* part of the window, you may wish to change from the P3 default of sorting by early start, then total float. However, this default is actually a useful way of sorting the activities.
- When the grouping and sorting structure is as desired, click **OK**.
- Scroll through the list of activities. Uncoded activities typically appear at the very bottom of the list.

Layouts

Once the schedule is organized in a desirable manner, it is helpful to save the layout. P3 allows up to 99 different layouts to be saved. This allows the scheduler to create many views of the project and save each layout for future reference.

To save a layout, follow these steps:

- Click **View**, **Layout**, **Save**
- If no layouts have been previously saved, P3 will default to layout number 01 with the description “Classic Schedule Layout.” Change the layout number to something else (02, for example) and enter a meaningful description (By Phase, for example). A meaningful description will help the scheduler to recognize the layout when needed at a later date.
- Click **OK**

Filters

There are several instances where it may be desirable to view part of a large schedule. For example, one may be interested at looking just at Phase 1 activities. A bridge inspector may be interested in seeing bridge activities only. A Contractor may be interested in providing part of a schedule to a subcontractor. One of the most helpful filters is to view the critical path only. P3 uses “filters” to present parts of schedules.

To set up a simple, one-level filter, follow these steps:

- Click **Format**, **Filter**

- P3 will display several "canned" filters that were developed for the example projects included with the software. The use of these canned filters is not recommended. It is much better to set up a filter for the specific project.
- Click **Add**. P3 will display the next filter number available.
- Enter a meaningful description.
- In the *Selection Criteria* part of the window, add the desired filter criteria to the "Select if" column by clicking the pick list button (▼) and scrolling through the available data.
- Click in the "Is" column and click the pick list button. The options are equal to, greater than, less than, etc. Pick the desired operand.
- Click the "Low Value" column, and type the desired value. Repeat this step in the "High Value" column if necessary.
- When the filter is properly defined, click **OK**
- To invoke the filter, highlight the desired filter and click **OK**.
- P3 will prompt the user for verification. Click **Yes** to complete the filter.

P3 allows multiple levels of filtering. This requires the use of "and/or" arguments. When ***and*** is used for multiple levels of filter specification, P3 will list all activities that meet ***all*** of the listed conditions. When ***or*** is used, P3 will list all activities that meet ***any*** of the conditions. The table below includes some common filters.

Filter description	Select if	Is	Low Value	High Value
Critical Path Only	Longest Path	Equals	Yes	
Phase X only	Phase *	Equals	X	
To find constraints	Constraint	Not Equal	*leave blank*	*leave blank*
To list activities numbered between 1000 and 2000	Activity ID	Within Range	1000	2000
To find activities with durations in excess of 20 days	Original Duration	Greater Than	20	
To find activities with the word "column" in the description	Activity description	Contains	Column	
To find critical activities in Phase 2 only	Longest Path	Equals	Yes	
	And			
	Phase *	Equals	2	
To find all bridge and culvert activities	Type *	Equals	Bridge	
	Or			
	Type *	Equals	Culvert	

* Note: These are user-defined. All others are system-defined.

Formatting Columns

As previously mentioned, P3 is a large relational database. The user can choose to view as much or as little of this data as desired. By default, P3 will show the following data in the columns to the far left of the screen: Activity ID, Activity Description, Original Duration, Remaining Duration, % Complete, Early Start, Early Finish, Resource and Budgeted Cost. To change the columnar data, follow these steps:

- Click **Format**, **Columns**
- P3 will show information regarding the currently displayed data. To hide columns, highlight the desired data and click the minus (-) button. Note: This does not delete the data, it just hides it.
- To display additional information, highlight the data you want the new data to appear before (to the left of) and click the plus button (+). P3 will insert a blank column above the highlighted data. Scroll through the list of data using the pick list button (▼) and highlight the desired data to display it.
- Click **OK**. P3 will now display the revised columnar data.

Many other options for formatting the schedule are available. However, for the purposes of schedule review, those discussed above should suffice.

Step 8. Calculate The Schedule

This step is necessary to ensure that the schedule does not contain loops and that the schedule is viable. This step also provides invaluable information into the schedule. Finally, this step recalculates the early start and finish dates and late start and finish dates, and calculates the total float for each activity. Thus, the critical path may be redefined.

To calculate the schedule:

- Click **Tools**, **Schedule**
- Make sure that an "x" appears to show *Constraints*, *Open Ends*, and *Activities with out-of sequence progress* (for new schedules, this option is meaningless).
- Click **OK**
- When P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the calculations and send the output to a companion program called "Primavera Look"
- Scroll through the output (discussion of the output is provided below).
- Remove page breaks by placing the cursor to the far left just above each break (usually a dotted red line). Hit enter and then backspace. Repeat for each break.
- Print the output and file. This is one of the most important pieces of paper generated during the schedule review process.
- Exit Primavera Look (not P3) by clicking **File**, **Exit**.
- P3 will prompt the user. Choose **No** (clicking Yes will save the output only) to return to the main P3 program.

P3 Schedule Calculations Output By Page

Page 1 provides general information regarding the schedule. Page 2 displays information regarding constraints, if any. Page 3 provides a listing of open-ended activities (those without predecessors and/or successors). As a minimum,

each schedule will have one activity (the project start) with no predecessors and one activity (project completion) with no successors. Page 4 will display activities with out-of-sequence progress, if any. The last page will provide scheduling statistics.

For an original schedule, the important information to note includes the number of activities and the number of activities in the longest path (critical path). Typically, one-third of the activities in original schedules are critical. It is important to note the number of relationships. Schedules with sound logic typically have more relationships than activities. However, if the number of relationships outnumbers the number of activities by a wide margin, the schedule might be overly restricted. Note the percent complete figure. P3 calculates this figure by determining the duration of started activities and dividing this amount by the total duration of the project. Finally, note the data date, the start date, the imposed finish date (if any), and the latest calculated early finish date.

Obtain a copy of the Project Schedule Status Report (paper copy of the form is included in Appendix A. An Excel Spreadsheet is also available).

Record the schedule name, data date, completion date (latest calculated early finish) and percent complete on this form. This form should be updated every time the Contractor submits an updated or revised project schedule (a complete guide to reviewing schedule updates is presented in Chapter 3).

Contract Time Calculator

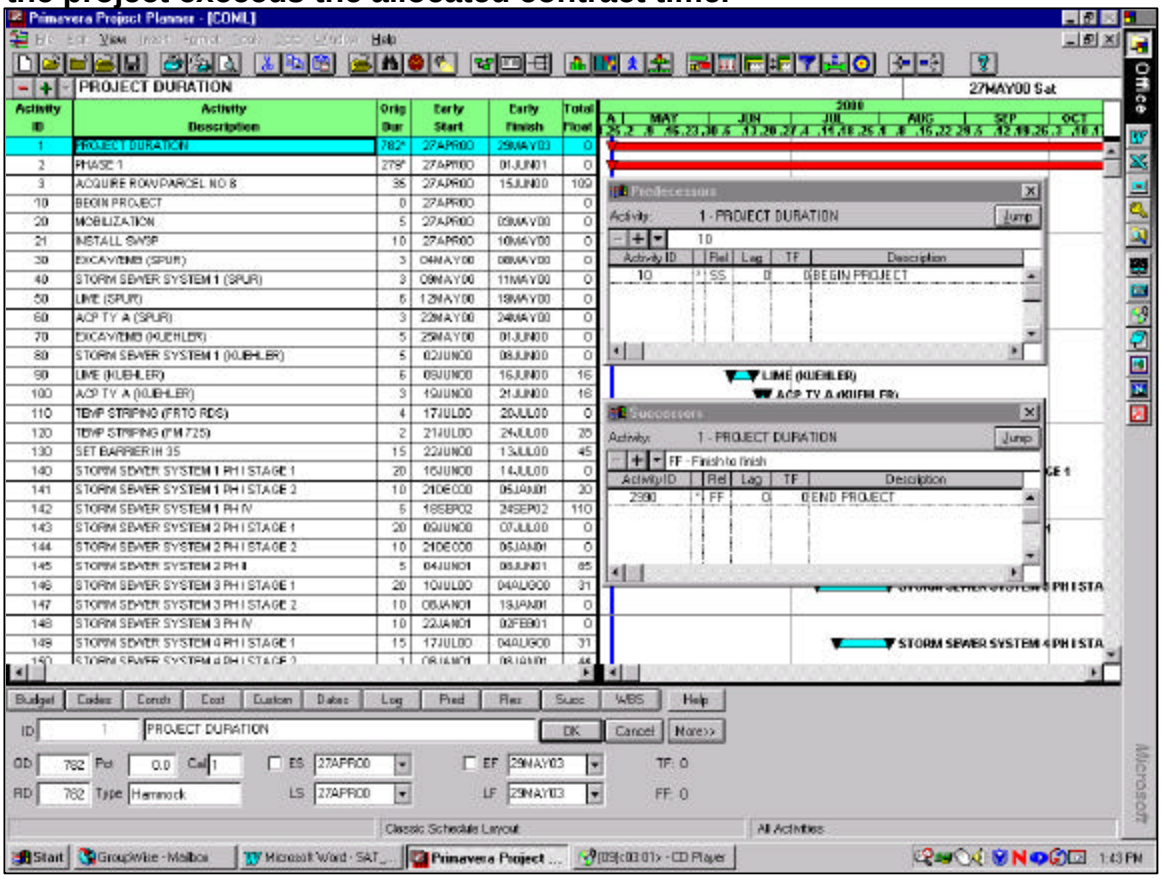
Some schedules include an activity that calculates the number of working days required to complete the project. As the schedule is updated, this activity recalculates the remaining working days automatically. The steps to create this activity are as follows:

- With the schedule organized by Phase, highlight the first activity and press the **Insert** key or click the plus button (+).
- P3 responds by adding a blank line to add an activity. At the bottom of the screen, a blank Activity Form may appear. If not, click **View**, **Activity Form**.
- Type an activity ID number and an activity description similar to “Contract Time Calculator” in the spaces provided. P3 may automatically assign an activity ID number. To disable this feature, click **Tools**, **Options**, **Activity Inserting**, and remove the “x” from the Automatically Number Activities box.
- Change the type of activity to “Hammock”
- Change the calendar to that one that best models how contract time will be charged.
- Find the activity that coincides with the beginning of time charges. Add this activity to the hammock as a predecessor. To do this, open the predecessor window by clicking the **Pred** button, click the plus button (+), click the pick list

button (▼), scroll through the list of activities, highlight the time start activity, and change the relationship type to SS.

- Click **OK**, close the Predecessor window.
- Add the last activity in the schedule to the hammock as a successor. Open the successor window by clicking the **Succ** button, click the plus button (+), click the pick list button (▼), scroll through the list of activities, highlight the last activity, and change the relationship type to FF.
- Click **OK**, close the Successor window.
- Recalculate the schedule. Exit Primavera Look.
- Find the hammock activity. Note the original duration – this is the number of working days that will be required to complete the project.

Note: An original schedule is unacceptable if the time required to complete the project exceeds the allocated contract time.



The example above shows a properly inserted Contract Time Calculator activity. This hammock activity starts when the project starts and ends when the project ends. Because P3 calculates the duration for hammock activities, there is no need to enter a duration when creating this activity.

Step 9. Review Constraints

Constraints impose restrictions on the schedule. They are used to model such things as when right-of-way will be available, when utilities will be out of the way, when materials will be available, etc.

Constraints aid in building a schedule that more accurately reflects the real world aspects of the project. Constraints also may create negative float. The only way a schedule can have negative float is if it has been constrained.

The following constraints may be encountered:

- **Imposed Finish Date** – this constraint affects the entire project. Schedulers sometimes enter an imposed finish date as wishful thinking.

- **Start-No-Earlier-Than** - this constraint prevents an activity from starting any earlier than the entered date.
  - Determines early start (ES) date
  - Pushes ES forward to constraint date
  - Affects only early dates
  - Used for availability of resources
  - Used for delivery dates such as ROW and Utilities

- **Finish-No-Later-Than** - this constraint prevents an activity from finishing later than the entered date.
  - Indicates the date an activity must finish
  - Takes effect if the calculated late finish is later than constraint
  - Affects late dates
  - Used to set intermediate completion points.

- **Start-No-Later-Than** – this constraint sets the late start date of an activity.
  - Takes effect only if late start date is later than the constraint date.
  - Pulls late start forward to constraint date.
  - Used to place a deadline on the start of an activity.

- **Start-On** - Imposed start-no-earlier-than and start-no-later-than constraint on same activity.

- **Total Float Equal to Zero** - Some schedulers use this constraint to force traffic changes to have zero float, for example, as an attempt to show them on the critical path. This is a poor substitute for good scheduling.

- **Milestones and Flags** – may be used to highlight the end of a phase or other important event
- **Mandatory Finish or Start** – used to set the early and late start and finish of activities.

Constraints can have a major impact on a schedule. Used properly, constraints can model activities like anticipated ROW acquisition dates, utility adjustment dates, or materials procurement dates. Used improperly, constraints can force the critical path and result in misleading schedules. The use of constraints should be minimized.

To review the constraints, if any, in a schedule:

- Review the scheduling calculation output created in Step 8. Note the activities with constraints. Find these activities in the schedule. There are two easy ways to find specific activities:
  - Click **Edit**, **Find**. You may enter the activity ID number in the blank or scroll through the activity listing using the pick list button (▼).
  - Set up a filter to show activities with constraints only. The criterion for this filter is presented in the table in Step 7.
- Review each activity with constraints. This can also be done two ways.
  - Click **View**, **Activity detail**, **Constraints**
  - Open the activity form by clicking **View**, **Activity form**. View the constraint by clicking the **Constr** button.
- If the constraint appears to be manipulating the schedule or creating negative float, it may be deleted by clicking the box to the left of the constraint description so that the "x" disappears.
- If constraints are removed, recalculate the schedule to see the difference.

Step 10. Prepare Plots And Prints

Several steps in the review process are best accomplished using paper copies of the schedule. These steps include checking the schedule against the TCP, checking to see if all work is included, checking for major scheduling blunders, and checking for open-ended activities. Two prints and one plot are needed.

Activity Listing Report

The activity listing is simply a list of all activities in a schedule. This report is easiest to use if the activities are sorted by activity ID. The following steps are required:

- Click **Tools**, **Tabular Reports**, **Schedule Reports**
- P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
- Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.
- Type a meaningful description such as "Activity Listing."
- Looking at the *Content* screen, make sure the Activity code line appears in the *Include the following data* part of the window. In the "Code" area, change the code to project-specific data like "Phase."

- For this report, the P3 defaults for the *Format* and *Selection* screens are acceptable.
- Click **OK** to save the report.
- Click **Run** to generate the report.
- If P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the report and send the output to Primavera Look.
- Scroll through the output.
- Print the output and file.
- Exit Primavera Look (not P3) by clicking **File**, **Exit**.
- P3 will prompt the user. Choose **No** (clicking Yes will save the output only) to return to the main P3 program.
- Close the reports window.

Detailed Predecessor And Successor Report

This report provides the scheduler with a listing of all relationships in the schedule. This report is easiest to use if the activities are sorted by activity ID. The following steps are required:

- Click **Tools**, **Tabular Reports**, **Schedule Reports**
- P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
- Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.
- Type a meaningful description such as “Detailed Pred & Succ Analysis.”
- Looking at the *Content* screen, make sure the Activity code line appears in the *Include the following data* part of the window. Highlight the Activity code line and click the plus button (+). P3 adds a blank line. Scroll through the list of options using the pick list button (▼), select Detailed Predecessor.
- Click just below the Activity code line and click the plus button (+). P3 adds a blank line. Scroll through the list of options using the pick list button (▼), select Detailed Successor. Change the “Skip lines” column next to the detailed successor to 2 or 3.
- In the “Code” area, change the code to project-specific data like “Phase.”
- For this report, the P3 defaults for the *Format* and *Selection* screens are acceptable.
- Click **OK** to save the report.
- Click **Run** to generate the report.
- If P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the report and send the output to Primavera Look.
- Scroll through the output.
- Print the output and file.
- Exit Primavera Look (not P3) by clicking **File**, **Exit**.

- P3 will prompt the user. Choose **No** (clicking Yes will save the output only) to return to the main P3 program.
- Close the reports window.

Time-Scaled Logic Diagram Plot

This plot provides a complete view of the schedule. Activities are drawn as bars, with the beginning and ending of the bars corresponding to the early start and early finish. The relationships are drawn between the activities. The critical path can be highlighted in red for easy recognition. The steps to prepare this plot are as follows:

- Set up the printer
  - Click **File**, **Print Setup**
  - Change to the specific printer using the pick list.
  - Set the orientation and paper size.
  - Make this the default printer (if these steps are not taken, the plot will be generated for the printer and paper size specified as the default).
  - Click **OK** to save changes.
- Click **Tools**, **Graphic Reports**, **Timescale Logic**
- P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
- Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.
- There are eight different screens that may be modified.
  - In the *Content* screen, type a meaningful plot title such as "Time Scaled Logic." The remaining areas may be left at the P3 defaults.
  - In the *Date* screen, change the start date to before the beginning of the project (SD-2W makes the plot begin two weeks before the beginning of the project) to allow space between data and the edge of the plot. Change the end date to after the project completion (FD+2M makes the plot begin two months after the end of the project) to allow space as well. The remaining areas may be left at the P3 defaults.
  - In the *Format* screen, Group the schedule by code structure that best resembles the sequence of work and traffic control plan shown in the contract (for example, by Phase). The remaining areas may be left at the P3 defaults.
  - In the *Sort* screen, change the sort to match the grouping in the *Format* screen.
  - In the *Pen* screen, change the progress highlighting to center of bar. This will allow one to distinguish between critical path activities and completed activities if the schedule plot is copied in black-and-white.
  - Leave the *Selection* screen blank if all activities are desired. Otherwise, select activities as described under Filters in Step 7.
  - In the *Size* screen, change the row separation to 15.

  - ♦ In the *Tailoring* screen, change the vertical sight lines to 0 (zero) months and change the critical activities to longest path.
- Click **OK** to save the report specifications.
- Click **Run** to generate the plot.
- If P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the report, and inform the user of how many pages are needed. If this is acceptable, click **OK** to send the output to Primavera Look. If not, click **Modify**, reduce some of the font sizes in the *Size* window, click **OK**, then re-run the report until it is acceptable. Several iterations of minor adjustments may be required to get the plot to fit on the desired number of pages.
- When the plot appears to be acceptable, plot a hard copy and use for remaining part of analysis.

Step 11. Complete The Schedule Review

In this step, it is necessary to compare the Contractor's schedule against the contract sequence of work and traffic control plan. While the Contractor is allowed to make changes in the TCP, the scheduling special provision prohibits the Contractor from making these changes by hiding them in a schedule. If the Contractor desires to change the TCP, they must submit a request to do so in writing. If the Contractor's schedule does not conform to the contract sequence of work and traffic control plan, the schedule should be rejected.

To complete the schedule review, follow these steps:

- Understand the contract sequence of work and TCP. It is helpful to create a project layout showing all the phases and steps in the sequence of work individually.
- It is also helpful to color the work in each phase or step, then color-coordinate the schedule plot created in Step 10 to match the TCP. This allows a quick comparison of work shown on the TCP as Phase 1 (in blue, for example) to work shown on the schedule plot as Phase 1, also colored blue.
- With an understanding of the contract sequence of work and a corresponding schedule plot, it is easy to check to see if all significant contract work is included in the schedule. It is not necessary to include all contract pay items in the schedule. Other than at the beginning of the project, SW3P activities rarely fall on the critical path. There is no reason to show each of the various combinations of striping color and configuration as schedule activities when all the striping for a traffic change can be shown as one activity. However, any work that may potentially affect the critical path should be included in the schedule.
- It is important to check for major scheduling blunders. For example, the schedule may show a bridge deck being complete before the drilled shafts are complete. A realistic schedule will not show physical impossibilities such as this.

- It is also important to check activity durations considering the quantity of work, difficulty of work, and assigned resources. Some schedulers may assign the same duration to vastly different items of work. For example, assume a contract includes several phases where excavation is required. The quantity of excavation differs from phase to phase. Thus, it may not be realistic to assign the same duration to each excavation activity.
- Schedules with open-ended activities are not realistic. When reviewing the output from the schedule calculations as described in Step 8, one may notice some open-ended activities. However, the schedule may contain open-ended activities not listed in the schedule calculation output. Consider activities with start-to-start relationships. From a practical standpoint, if the ends of the activities are not also tied using finish-to-finish relationships, they are open-ended. P3 does not consider these activities as open-ended because, in theory, they have successors. In this case, the theoretical definition of "open-ended" differs from the practical definition. The easiest way to detect this condition is by reviewing a time-scale logic diagram.

When the schedule review is complete, decide whether the schedule meets the requirements of the CPM special provisions, and complete the Schedule Review Checklist. Make a copy of the checklist, the printed reports and plots, and send a copy to the Contractor. The originals should be filed in the project documentation.

Chapter 3
Review Process For Updated/Revised Schedules
(Computer Monitoring Of CPM Schedules)

Overview And Roles

Once the Contractor has submitted an acceptable schedule and has started work, the Contractor shall submit updated schedules every month. Without these schedule updates, it is impossible to determine the critical path from month to month.

Contractor/Department Joint Role:

Both parties should participate in monthly update meetings. The purpose of this meeting is for the Contractor and the department to agree on the progress information prior to updating the schedule. This information includes actual start and finish dates, percent complete figures, and schedule corrections including out of sequence work prior to updating the schedule.

Contractor Role:

The Contractor's role is to update the schedule monthly after reviewing the prior month's progress with the department and to provide an electronic copy (via floppy disk) to the department. The Contractor may need to revise the schedule if the schedule fails to match the contract sequence of work. The sequence of work may be changed by change orders, project impacts, the Contractor's initiative or by orders of the Engineer.

During the project, the Contractor is responsible for monitoring the progress of the work, recognizing potential impacts, and providing Time Impact Analyses (TIAs) to the department when a time extension or suspension may be needed. To be in complete compliance with the contract, the Contractor should submit the TIA no later than one estimate cycle after the Contractor received the contract time statement when the impact occurred. For example, if an impact occurred in March, the Contractor would receive the time statement in early April. The Contractor would have until the beginning of May to protest the time charges and submit a TIA to the department. It is important to recognize that there may be extenuating circumstances that may prevent the Contractor from providing the timely notice of a potential impact. However, these instances should be the exception rather than the rule. See Chapter 4 for a detailed description of the Time Impact Analysis process.

Department Role:

The department's role is to monitor the project's progress and review time extension and time suspension requests. Any time extensions or suspensions should be granted accurately and timely. The department should use the

Contractor's schedule to make daily decisions on time charges. The department should document the Contractor's progress for use in the monthly update meetings.

Preliminary Activities

Scan the floppy disk for viruses. If a virus is detected, remove the floppy disk from the drive, notify district Information Systems personnel, and request the Contractor to provide a new disk. If the diskette is clean, proceed with the analysis.

Locate the drive and directory or folder created for the particular project during the original schedule review. The updated schedules should be stored here as well. Also locate the Project Schedule Status Report started during the original schedule review. The status of the project at each of the monthly updates will be documented on this form.

Schedule Review

The following steps are necessary to review a schedule for compliance with the CPM special provisions. All of the steps are necessary for a comprehensive review. The steps do not necessarily need to be taken in the exact order as presented below. However, following the prescribed order may prevent rework.

Step 1. Restore The Schedule

As with the original schedule, the first step is to restore the schedule update to the network or local hard drive. The following steps are involved:

- Get into P3.
- Click **Tools**, **Project Utilities**, **Restore**
- In the *From* portion of the window, locate the desired project on the floppy drive. Double click the box to the left of the schedule name so that a check mark appears.
- In the *To* portion of the window, change the directory to the desired drive and directory, click the boxes to the left of the Restore Tabular Reports and Restore External Relationships so that "x" appears.
- Click **Restore**, **OK**.
- P3 may respond with the following warning message: "Project XXXX already exists. Overwrite?" If so, click **No**. This message means the Contractor may be creating the monthly updates by adding progress to the original schedule. If this is done, the original schedule is being destroyed one month at a time. Notify the Contractor of this major potential problem. Copy the previously restored schedule to another name in the same directory by clicking **Tools**, **Project Utilities**, **Copy**. In the *From* part of the window, locate the previously restored schedule. Highlight the desired project. In the *To* part of the window, change the drive and directory to the same location as in the

From part of the window, and type in a new project name in the *Project Group* box. Note: P3 requires all project names to be exactly four characters in length. Click **OK** to copy the schedule. After the schedule has been successfully copied, restore the updated schedule as described above.

- After restoration is complete, click **OK**.

Step 2. Open The File

Open the desired file. It is important to note that P3 saves data as it is added, deleted, and/or changed, and that there is no "undo" command.

- Click **File**, **Open**. Locate newly restored project. The drive and directory may need to be changed.
- Highlight the desired project and click the **Overview** button.
- In the *Overview* window, look for imposed finish date. Remove if this date is earlier than the calculated early finish date.
- Click **Open**.

Step 3. Review The Schedule For Conformance To The Specifications

Follow Steps 3, 4, 5, 6, 7 and 9 for original schedules (see Chapter 2). Unless the Contractor has made wholesale changes to the schedule, these review steps should be fairly easy and quick.

Step 4. Set Up Target Schedules

P3 allows the comparison of one schedule to up to two other "Target" schedules. For uniformity, set up Target 1 as the comparison to the previous monthly update and reserve Target 2 for comparison to the original schedule.

P3 keys on the activity ID numbers of the different schedules for this comparison. Thus, if the Contractor makes significant changes to the activity ID numbering system, the target comparison may not be valid.

To set up a target schedule for comparison:

- Click **Tools**, **Project Utilities**, **Targets**
- Select the desired schedule by typing in the name or by using the pick list button (▼).
- When the desired schedule appears in the list of targets, click **OK**.
- Next, format the schedule so that the target appears. Click **Format**, **Bars**. Add a new bar by clicking the plus button (+).
  - ♦ Enter a meaningful description such as "Target" in the description box.
  - ♦ Change the position to 3 (for each activity, this will make the target bar appear below the updated schedule bar).

  - ♦ Click the pick list button (▼) in the *Structure* part of the window, scroll through the data and click "Target 1 early start." Note that in the "Type" column, the start point is now defined as the "Target 1 early start." Repeat this last step to set the finish point to "Target 1 early finish."
  - ♦ Click **OK**. Make sure that the box in the column titled "Visible" is checked for the newly created bar. Click **Close**.
- P3 will reorganize the schedule to display both the updated and the target schedules.
- Save the target comparison layout by clicking **View**, **Layout**, **Save as**. Enter a new layout number and description, and click **OK**.

It is helpful if prints and plots of the updated schedule are created at this point.

Step 5. Review Status Of Updated Schedule

Review each started activity in the schedule update. Using project documentation, verify the actual start date, actual finish date, and percent complete for each activity. **This is especially important for any critical activity in the target schedule and any activity that is critical in the updated schedule.**

For activities that were critical in the target schedule, it is important to determine if these activities are ahead of schedule or behind schedule. Refer to the following example of an activity that is behind schedule:

Looking at this activity, the target bar (the bar on the bottom with the square end points) is to the left of the update bar (the bar with the triangular end points). This means the early start and finish of the updated activity is now later than in the target schedule. If this activity were ahead of schedule, the target bar would be to the right of the update bar.

In the same manner, review activities that were not critical in the target schedule that now appear as critical in the updated schedule.

Look for any activities that have been added since the previous update (change orders, unanticipated work, etc.). For these activities, no target bar will appear. Look for activities that have been deleted since the previous update.

Step 6. Recalculate The Schedule

Run the schedule calculations. To calculate the schedule:

- Click **Tools**, **Schedule**
- Make sure that an "x" appears to show Constraints, Open Ends, and Activities with out-of sequence progress.
- Click **Options**. Select the Retained Logic option using the radio dial (⊙). In some schedules, the results of the schedule calculations can differ vastly between the retained logic and progress override options. The difference between these options will be discussed later. Close the options window by clicking **OK**.
- Click **OK**
- When P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the calculations and send the output to a companion program called "Primavera Look."
- Scroll through the output (discussion of the output is provided below).
- Remove page breaks by placing the cursor to the far left just above each break (usually a dotted red line). Hit enter and the backspace. Repeat for each break.
- Print the output and file. This is one of the most important pieces of paper generated during the schedule review process.
- Exit Primavera Look (not P3) by clicking **File**, **Exit**.
- P3 will prompt the user. Choose **No** (clicking Yes will save the output only) to return to the main P3 program.

Review the output. Note the revised early completion date. Note out-of-sequence progress, if any. Pay particular attention to any message similar to "Activity 100 has an actual start/finish date on or beyond the data date." Translated into plain English, this message means "Activity 100 happened today or tomorrow." If the date in question is the same as the data date (today), ignore the message. However, if the date in question is beyond the data date (tomorrow), the actual date needs to be corrected.

Step 7. Prepare Plots And Prints

Several steps in the review process are best accomplished using paper copies of the schedule. If the schedule user created reports and plots as part of the original schedule review, they may be copied into the schedule update. This is accomplished by using P3's "transfer" function. To transfer a report, follow these steps:

- Click **Tools**, **Tabular Reports**, **Schedule Reports**
- P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
- Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.

- Click **Transfer**. P3 will list all of the schedules in the active directory or folder. Locate the desired schedule and highlight it (it may be necessary to change the drive and/or the directory). P3 will provide a list of all reports in that schedule. Locate the desired report and highlight it. Click **OK**.
- P3 will copy the report specifications. Modify these specs if desired and click **OK** to save the report.

If the reports were not created, create the reports and plot identified in Step 10 of the Original Schedule Review (Chapter 2).

Also, create the following print and plot:

Target Comparison Report

- Create a new report.
  - Click **Tools**, **Tabular Reports**, **Schedule Reports**
  - P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
  - Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.
  - Type a meaningful report description such as "Target Comparison."
  - Looking at the *Content* screen, make sure the Activity code line appears in the *Include the following data* part of the window. In the "Code" area, change the code to project-specific data like "Phase."
  - In the *Format* screen, click the radio dial (⊙) that corresponds to the proper target schedule, usually Target 1.
  - Make sure all the options in the *Display* section of the window are marked with "x."
  - The default values for the *Selection* screens are acceptable.
  - Click **OK** to save the report.
  - Click **Run** to generate the report.
  - If P3 prompts the user, choose View on screen and click **OK**.
  - P3 will complete the report and send the output to Primavera Look.
  - Scroll through the output.
  - Print the output and file.
  - Exit Primavera Look (not P3) by clicking **File**, **Exit**.
  - P3 will prompt the user. Choose **No** (clicking Yes will save the output only) to return to the main P3 program.
  - Close the reports window.
  - Analyze the output.

Target Comparison Bar Chart

This plot provides a complete view of the schedule including the target for comparison (Note: a time-scale logic diagram with a target comparison is not possible). Activities are drawn as bars, with the beginning and ending of the bars corresponding to the early start and early finish. The critical path can be highlighted in red for easy recognition. The steps to prepare this plot are as follows:

- Set up the printer.
  - Click **File**, **Print Setup**
  - Change to the specific printer using the pick list.
  - Set the orientation and paper size.
  - Make this the default printer (if these steps are not taken, the plot will be generated for the printer and paper size specified as the default).
  - Click **OK** to save changes.
- Click **Tools**, **Graphic Reports**, **Bar Chart**
- P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
- Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.
- There are eight different screens that may be modified.
  - In the *Activity Content* screen, type a meaningful plot title such as "Target Comparison." In the *Specifications* part of the screen, make sure that Activity ID, Early Dates, Remaining Duration and Percent Complete are shown.
  - In the *Content* screen, make sure that the plot shows dates for the target schedule. The remaining areas may be left at the P3 defaults.
  - In the *Date* screen, change the start date to before the beginning of the project (SD-2W makes the plot begin two weeks before the beginning of the project) to allow space between data and the edge of the plot. Change the end date to after the project completion (FD+2M makes the plot begin two months after the end of the project) to allow space as well. The remaining areas may be left at the P3 defaults.
  - In the *Format* screen, Group the schedule by code structure that best resembles the sequence of work and traffic control plan shown in the contract (for example, by Phase). The remaining areas may be left at the P3 defaults. In the *Sort* part of this screen, change the first sort to match the grouping in the *Format* screen.
  - In the *Pen* screen, change the progress highlighting to center of bar. This will allow one to distinguish between critical path activities and completed activities if the schedule plot is copied in black-and-white.
  - Leave the *Selection* screen blank if all activities are desired. Otherwise, select activities as described under Filters (Step 7 of Chapter 2)
  - The *Size* screen may be left at the P3 defaults.

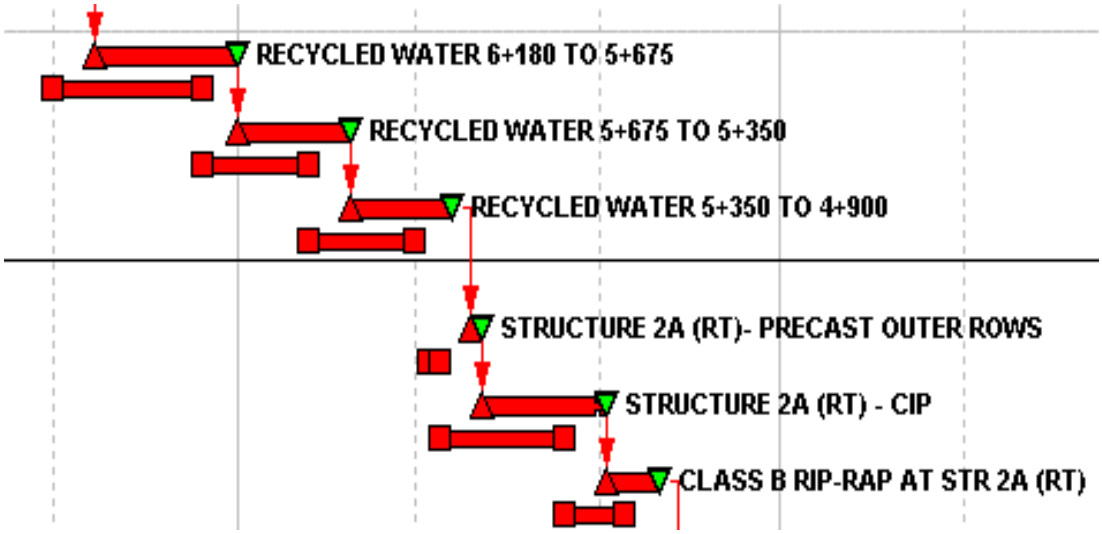
  - ♦ In the *Tailoring* screen, change the vertical sight lines to 1 month and change the critical activities to longest path.
- Click **OK** to save the report specifications.
- Click **Run** to generate the plot.
- If P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the report, and inform the user of how many pages are needed. If this is acceptable, click **OK** to send the output to Primavera Look. If not, click **Modify**, reduce some of the font sizes in the *Size* window, click **OK**, then re-run the report until it is acceptable. Several iterations of minor adjustments may be required to get the plot to fit on the desired number of pages.
- When the plot appears to be acceptable, plot a hard copy and use for remaining part of analysis.

Step 8. Decide If The Schedule Has Been Updated Or Revised

Although these two terms are often used synonymously, they have entirely different meanings. A ***schedule update*** is defined as the addition of actual start dates and/or actual finish dates to activities that have been started and/or completed, and revising the percent complete figure or the remaining duration figure for started activities. Minor revisions to schedule logic (relationships) may be accomplished through schedule updates. Other than the submission of an updated schedule, no paperwork is required. A ***schedule revision*** is defined as adding or deleting activities, relationships, resources, or any other component of the schedule, or changing durations. Schedule revisions are required when the project sequence of work is changed. TxDOT may request the Contractor to revise the schedule to incorporate a change order into the schedule. The Contractor may request to revise the schedule to get the project back on time. Schedule revisions should be documented in writing.

The following steps may help determine if a schedule has been updated or revised:

- Generally, schedule revisions will not drastically change the critical path of future activities. Through the updating process, the start and finish dates of each individual activity in the updated schedule may be earlier or later than the corresponding activities in the target schedule. However, the critical path will generally follow the same order in an updated schedule as in the target schedule. This concept is illustrated below:



When a schedule is revised, the critical path may not follow the same logic as in the target schedule.

- Compare the paper copies of the *Activity Listing* and *Detailed Pred & Succ Report* for both target and updated schedules.
- Review the new *Target Comparison* report and plot.
- In some complex schedules, it may be impossible to determine whether a schedule has been revised or simply updated. In these cases, a program called "Claim Digger" may be needed. This utility compares all aspects of two schedules and prepares a list of differences. If this step is needed, contact the District Construction Office for assistance.

Step 9. Document The Schedule Update Status

If the updated schedule is acceptable, compare the updated schedule completion date to the previous schedule completion date. Note any deviations between the update and the previous schedule. If the target schedule shows a completion date earlier or later than the target schedule, identify the cause of the change and document the findings on a **Project Schedule Status Report** (see Appendix A).

It may be helpful to document the findings in the schedule itself. This is best accomplished by utilizing P3's log feature. To create a log entry:

- Highlight the desired activity.
- Open the activity form by clicking **View**, **Activity Form**
- Open the log window by clicking the **Log** button.
- Type your entry in the space provided. P3 allows up to 99 different log records per activity. Each of the log entries can be displayed or hidden using

the check box. When complete, close the log window by clicking the **Log** button again. Close the activity form.

- To view the log in the bar chart area, click **Format**, **Bars**. Highlight the early start bar and click **Modify**. In the *Text* part of the window, add a new line by clicking the plus button (+). Select a position using the pick list button (▼). In the newly added row, highlight the Data column, scroll through the data using the pick list button (▼), find Log Record and highlight. Change the font size if desired. The two rightmost columns allow the user to choose which log records to be displayed. If multiple logs may be needed, set the end log to 99. This will prevent the user from needing to modify the bar format again. Click **OK** when done, and close the Bars window. P3 will reorganize the layout and display the logs.

Update The Project Documentation

The project files should include the following information:

- Paper copies of the original schedule, updated schedules and revised schedules.
- Diskette of the original schedule, updated schedules and revised schedules.
- The schedule review checklist.
- An up-to-date Project Schedule Status Report.
- Any time impact analysis (TIA) submitted by the Contractor along with TxDOT's response to the TIA (see Chapter 4 for a complete TIA Review Process).

Step 10. Prepare Look-ahead Schedule Plot

The look-ahead schedule is one of the most useful schedule plots that P3 can create. This plot shows activity during the previous month so that project personnel can verify the actual start and finish dates. This plot also shows work activities planned for the next two months. This allows the Contractor to order materials, schedule equipment and crews, coordinate subcontractors, and anticipate problems. For TxDOT, this schedule plot can be used to assign inspectors to projects where the workload demands inspection.

To create this plot:

- Set up the printer.
  - Click **File**, **Print Setup**
  - Change to the specific printer using the pick list.
  - Set the orientation and paper size (this plot should be printed in black and white on 8-½" x 11" paper).
  - Make this the default printer (if these steps are not taken, the plot will be generated for the printer and paper size specified as the default).
  - Click **OK** to save changes.
- Click **Tools**, **Graphic Reports**, **Bar Chart**

- P3 will provide many canned reports. The use of these canned reports is not recommended. It is much better to set up a report for the specific project.
- Click **Add**. P3 will respond by showing the next available schedule report number. Click **OK**.
- There are eight different screens that may be modified.
  - In the *Activity Content* screen, type a meaningful plot title such as "Look-ahead Schedule." In the *Specifications* part of the screen, make sure that Activity ID, Early Dates, Remaining Duration and Percent Complete are shown. Change the *Lines for activity data* to 2 and set the *Activity title length* to 20.
  - In the *Content* screen, make sure that the plot shows dates for the target schedule. The remaining areas may be left at the P3 defaults.
  - In the *Date* screen, change the start date to one six weeks before the update date (DD-6W) to allow space to the left of plotted data. Change the end date to three months after the update date (DD+3M) to allow space to the right of plotted data. The remaining areas may be left at the P3 defaults.
  - In the *Format* screen, Group the schedule by code structure that best resembles the sequence of work and traffic control plan shown in the contract (for example, by Phase). The remaining areas may be left at the P3 defaults. In the *Sort* part of this screen, change the first sort to match the grouping set up earlier.
  - In the *Pen* screen, change the progress highlighting to center of bar. This will allow one to distinguish between critical path activities and completed activities if the schedule plot is copied in black-and-white.
  - In the *Selection* screen, create a filter to show all work activities active in the previous month and those that are planned for the upcoming month. There are two specifications for this filter:

Select if	is	Low Value	High Value
Actual dates	WR	DD-1M	DD+0D
Early dates	WR	DD+0D	DD+2M

    Make sure the radio dial (⊙) next to *Any* is marked.
  - The *Size* screen may be left at the P3 defaults.
  - In the *Tailoring* screen, change the vertical sight lines to 1 month and change the critical activities to longest path.
- Click **OK** to save the report specifications.
- Click **Run** to generate the plot.
- If P3 prompts the user, choose View on screen and click **OK**.
- P3 will complete the report, and inform the user of how many pages are needed. If this is acceptable, click **OK** to send the output to Primavera Look. If not, click **Modify**, reduce some of the font sizes in the *Size* window, click **OK**, then re-run the report until it is acceptable. Several iterations of minor

adjustments may be required to get the plot to fit on the desired number of pages.

- When the plot appears to be acceptable, plot a hard copy for the inspector's use.

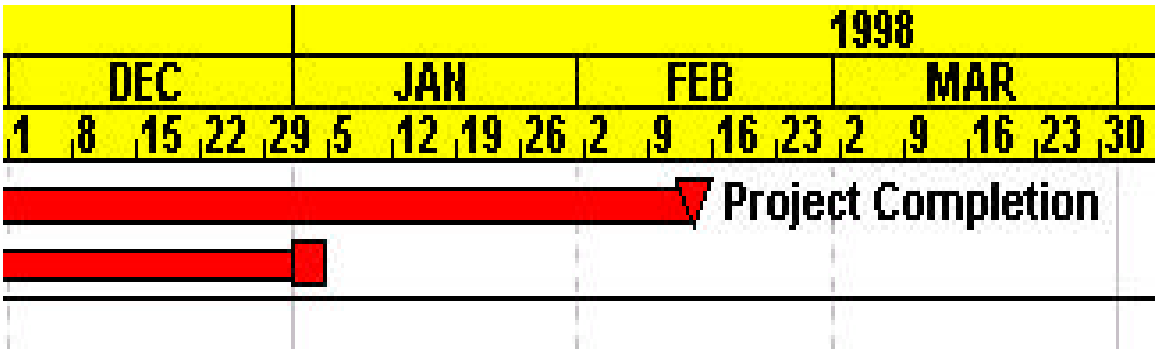
As with any P3 plot, once the look-ahead schedule plot has been created in one schedule, it can be transferred to another schedule.

Chapter 4
Time Impact Analysis Process For CPM Schedules

Overview and Roles

Delays are Impacts that extend the total project duration beyond the expected completion date. Figure 4 illustrates a project delay.

Figure 4
Example of Project Delay



Contractor/Department Joint Role:

Both parties should actively monitor the schedule and be aware when the project end date starts to slip. This is an indication that a delay is present. It is important to discover the presence of project delays as early as possible, so that mitigative efforts may be enacted. Both parties are responsible for mitigating the impact if at all possible. If these efforts are not possible, it is important for both parties to be aware that the delay is taking place so that accurate documentation of cost may be maintained. Finally, both parties are responsible for calculating the amount of time the impact cost the project as well as the monetary cost of the delay.

Contractor Role:

The Contractor's role is to update the schedule monthly after reviewing the prior month's progress with the department and to provide an electronic copy (via floppy disk or e-mail) to the department. The Contractor is wholly and singularly responsible for initiating Time Impact Analyses when delays are present. Refer to SP 008---118, which states “The Contractor shall notify the Engineer when an impact may justify an extension of contract time or adjustment of milestone

dates." Thus, if the Contractor believes the project has been delayed, the Contractor must initiate the Time Impact Analysis process.

SP 008---118 also states "When changes are initiated or impacts are experienced, the Contractor shall submit to the Engineer a written time impact analysis describing the influence of each change or impact." This sentence means the Contractor must submit a Time Impact Analysis if they believe additional contract time may be justified for a Change Order.

Department Role:

The department's role is to monitor the project's progress and review time extension and time suspension requests. Any time extensions or suspensions should be granted accurately and timely.

Project Delay – The Basics

Before going into detail of the time impact analysis process itself, it is important to know **why** the analysis is being done. The Contractor will submit a TIA when they believe the project has been delayed. If so, they may want time and money for the delay. It is crucial that TxDOT be able to decide if time may be justified before starting the TIA review process. Once TxDOT agrees that additional time may be justifiable, it is crucial for the department to decide if the Contractor deserves additional monetary compensation for the delay.

Making these decisions involves a four-step process. This process involves identifying the cause of the problem, determining the responsibility for the problem, determining how the problem impacted the project, and then calculating the cost. Discussing the entire process is beyond the scope of this document[1]. Therefore, for the purposes of this document, we will focus on calculating delay time only.

Time Impact Analysis Methodology – General Information

There are three common methods for calculating project delay.

- ◊ **The As-Planned Impacted Schedule Analysis (not recommended).** This analysis method takes the Contractors original schedule and ties owner-responsible impacts into the network. The ending date is calculated and compared to the original date. The delay period is the difference between the planned completion date and the impacted completion date. This method assumes the Contractor followed the original schedule exactly and exactly met anticipated production rates except for the impacts. This method fails to consider changes in sequences and mitigative efforts.

[1] Refer to the *Dispute Resolution Conference* workbook published by the Construction Division for more information.

◊ **The As-Built But-For Schedule Analysis (not recommended).** This method is used to determine the earliest date the Contractor could have completed the project without the owner-caused impacts. This method is performed by taking the as-built project schedule and removing owner-responsible delays. The ending date is then recalculated and compared to the actual completion date. This method is difficult to perform and easy to manipulate. Because this method uses the as-built schedule, the delay duration cannot be calculated until the project is complete or until a major phase or milestone is met.

◊ **The Contemporaneous Schedule Analysis (recommended approach).** This method involves determining the status of the project before an impact occurs, predicting the effect of the impact on the schedule, tracking the actual effects of the impact, and then calculating the actual effect of the impact. In summary form, these steps are discussed below: [2]

Step 1. Establish the status of the project before the impact using the most recent project schedule update prior to the impact occurrence.

Step 2. Predict the effect of the impact on the most recent project schedule update prior to the impact occurrence. This requires estimating the duration of the impact and inserting the impact into the schedule update. The Contractor shall demonstrate how the impact was inserted into the schedule using a fragnet. This is the presentation of a fragmentary portion of the schedule network showing the added or modified activities and the added or modified relationships. Any other changes made to the schedule including modifications to the calendars or constraints shall be noted.

Step 3. Track the effects of the impact on the schedule during its occurrence. Note any changes in sequencing, and mitigation efforts.

Step 4. Compare the status of the work prior to the impact (Step 1) to the prediction of the effect of the impact (Step 2), and to the status of the work during the impact (Step 3) and after the effects of the impact are over (Step 4). Note that if an impact causes a lack of access to a portion of the project, the effects of the impact may extend to include a reasonable period for remobilization.

The entire process is discussed below. Included in this discussion is a detailed discussion of each of the steps.

In many aspects, schedule analysis is an art, not a science. There are many documented methods for analyzing a schedule for delays. With the advent of

[2] From Special Provision 008---118 (1993 Specifications)

computers and the widespread usage of computerized CPM schedules, one schedule analysis method has become preferred. This method, often referred to as the "window analysis," compares the schedule before the impact to the schedule right after the impact. Looking through this "window" provides the scheduler an opportunity to isolate the cause of the delay and to calculate its impact on the project completion date. This method is contractually required in TxDOT's advanced CPM scheduling specification.

The process of creating an original schedule followed by creating monthly updates can be viewed as a basic window analysis. Each month, the project status should be compared to the status of the prior month. With this information, it is easy to determine if the project has gained or lost time during the last update period. Determining the cause or causes of the gains or losses may prove to be difficult, but it is possible and necessary. If TxDOT responsible impacts cause the project to be delayed, this information may be used as the basis for a time extension and may be the basis for paying the Contractor for delay damages. If the project was delayed by other factors, no time or compensation may be granted. Thus, determining the cause of project delay and identifying the contractual responsibility for the delay are vital decisions.

The project schedule status report should be the starting point for any delay analysis (see example below).

Project:	**STP 99(999)MM**	**County:**	**Bexar**
CSJ:	**0915-12-999**	**Contractor:**	**Joe Contractor, Inc.**

Schedule Name	Data Date	Comp. Date	Period Gain/Loss	Cumulative Gain/Loss	TxDOT Loss	Explanation for Loss/Gain
ORIG	**01/01/1997**	**02/05/1998**				
0397	**03/03/1997**	**02/05/1998**	0	0		**On schedule**
0597	**05/06/1997**	**02/08/1998**	-3	-3	**-3**	**HazMat @ Sta 115+00**
0697	**06/01/1997**	**02/11/1998**	-3	-6	**-3**	**HazMat**
0797	**07/01/1997**	**03/09/1998**	-26	-32	**-26**	**HazMat**
0897	**08/01/1997**	**03/30/1998**	-21	-53	**-21**	**HazMat**
0997	**09/01/1997**	**03/16/1998**	14	-39	**14**	**Mitigation effort - open Phase 2 early**
1197	**11/05/1997**	**03/05/1998**	11	-28		**Good production rates**
1297	**12/01/1997**	**03/11/1998**	-6	-34		**8" water line conflict**
0198	**01/01/1998**	**03/25/1998**	-14	-48		**8" water line conflict**
0298	**02/01/1998**	**04/01/1998**	-7	-55		**8" water line conflict**
0398	**03/01/1998**	**04/18/1998**	-17	-72		**8" water line conflict**
0498	**04/01/1998**	**04/22/1998**	-4	-76		**Contractor delay - subs not available**
COMP	**07/09/1998**	**04/29/1998**	-7	-83		**Contractor delay - subs not available**

In this example, note that three separate impacts delayed the project. First, the HazMat at Station 115+00 delayed the project. This impact pushed the ending date from 2/5/98 to 3/16/98, a total delay duration of 39 calendar days. Note that the effect of mitigation efforts, starting work on Phase 2 early, should be included in the analysis. The Contractor may argue that they are entitled to a time

extension of 53 days. Thus, TxDOT should make it a standard practice to search for ways to mitigate delays and, if a viable option is discovered, direct the Contractor to mitigate the impact. The Contractor has the implied responsibility to mitigate the effects of delay and should comply with the directive. If not, the Contractor may forfeit its right to claim for overhead expenses. In the example above, TxDOT should grant the Contractor a time extension of 39 calendar days, not 53 days.

The second impact, the conflict with the 8" water line (from 3/5/98 to 4/18/98), overlaps some of the time frame spanned by the first impact (from 2/5/98 to 3/16/98). In this case, TxDOT should grant additional time only to the point that the second and subsequent impacts extend the project completion date beyond the original impact or impacts. In other words, TxDOT should not grant two or more days for the same calendar day. In the example presented above, TxDOT should extend contract time by 33 calendar days (to extend time to 4/18/98).

Note that the last two months of the project were delayed by Contractor responsible impacts. No additional time should be granted for these impacts.

In most instances, the project schedule status report will show a project delay very clearly. This report pinpoints to TxDOT and the Contractor the months that delays most likely occurred. Further analysis of these monthly updates would identify the exact cause of a delay and calculate, as accurately as possible, the duration of the delay.

Infrequently, the Contractor may believe a particular impact delayed the project during a month when the project schedule status report shows no delay occurred. It is usually difficult for a Contractor to prove the project was delayed during a certain month when the project schedule updates do not reflect delay. In this author's opinion, this unique situation is only possible when:

- The project was delayed by a short term impact that occurred fully in one month (i.e., between two monthly schedule updates); and,
- The Contractor overcame the effects of the delay during that same month by:
  - achieving better than expected production rates,
  - encountering better that expected weather, and/or
  - accelerating or re-sequencing the project.

Under these circumstances, the Contractor may create interim project schedules to pinpoint and prove a delay (see Schedule Analysis Step 1 below).

Time Impact Analysis – Detailed Process

According to SP 008---118, there are two different ways to perform an acceptable Time Impact Analysis (TIA). The first method is to perform Steps 1 and 2 only. This method is essentially a pre-impact TIA. The second method is to perform Steps 1-4 after the impact is over (post-impact TIA). The pre-impact

TIA can be used to grant additional time (and may therefore be used to calculate delay damages) if:

- the duration of the impact is relatively certain;
- the impact activity is inserted into the network in a reasonable and logical manner;
- methods to mitigate the delay have been modeled into the network, and;
- the time impact analysis is submitted by the Contractor and accepted by the department prior to the completion of the impact.

This method is preferred for change orders.

Otherwise, the addition of time cannot be made until at least steps 1, 2, and 4 have been completed (step 3 is optional and is intended for use for long-duration impacts). Note that step 4 cannot be performed until the impact is over. It is critical for both parties to agree when the impact is over. TxDOT may choose to say the impact is over after the effects of all mitigating efforts are noted. The Contractor may not agree that the impact is over until crew usage and productivity has returned to pre-impact levels. Before starting step 4, make sure that both parties agree that the impact is **over**.

Step 1. Determine the status of the project immediately before the impact begins.

The window analysis method may be described as a "before and after" analysis approach. The analysis involves identifying the status of the project before an impact then again looking at the status after the impact. Changes to the project completion date may be attributed to the impact if the impact was to critical path activities or forced non-critical activities to become critical.

This step is **mandatory for both pre-impact and post-impact TIAs**. To determine the status of the project before the impact, do the following:

- From project documentation, determine the date the impact was first recognized by either party. This documentation may be in the form of letters, diary entries, or other correspondence. Generally, the impact begins when the work is **physically affected**. Resist the temptation to consider the first documented discussion of a potential change order, for example, as the start of the impact.
- Locate the monthly update (or interim schedule as described below) that has a data date just before the impact was recognized. If the impact was at the beginning of the project, the original detailed or preliminary schedule may be used. Calculate the schedule and print the results. Look for constraints and imposed finish dates. If these exist, it is recommended to remove them and recalculate the schedule. This schedule will be hereafter used as the target and the calculated early finish date will be used as the date to calculate delay.

- Study the critical path. Understand the sequencing of the project and understand what comprises the critical path for the remaining work.
- Document the results.

Creating Interim Schedules

Note that unless the impact starts right at start of the month, it may be necessary for the Contractor to develop an interim schedule update. Also, it may be that the Contractor did not submit a monthly schedule update as required by the specs. If an updated schedule or an interim schedule is needed, these schedules may be created after the fact. This can be accomplished in two ways (the first method is preferred).

1) The scheduler may make a copy of the regular schedule update created at the beginning of the month before the impact starts and create an interim update by adding progress (actual start dates, actual finish dates, percent completes and/or remaining durations). To create this schedule, follow these steps:

   - Create a copy of the monthly update prior to the start of the impact. Open the newly created interim schedule.
   - From the project records, determine the schedule activities that the Contractor worked on between the date of the regular monthly schedule update and the date of the interim schedule. Keep in mind that the interim schedule is being created to determine the project status ***just before*** the impact began. The data date for the interim schedule should therefore be the day the impact began. Determine actual start dates, actual finish dates and percent complete (or remaining duration) for each of these activities as of the interim schedule date.
   - Update the interim schedule to reflect the data collected in the step above. For each activity needing to be updated, enter an actual start or finish date.
   - When all the activities have been updated, change the data date and recalculate the schedule. Compare the ending date to the previous regular monthly update.

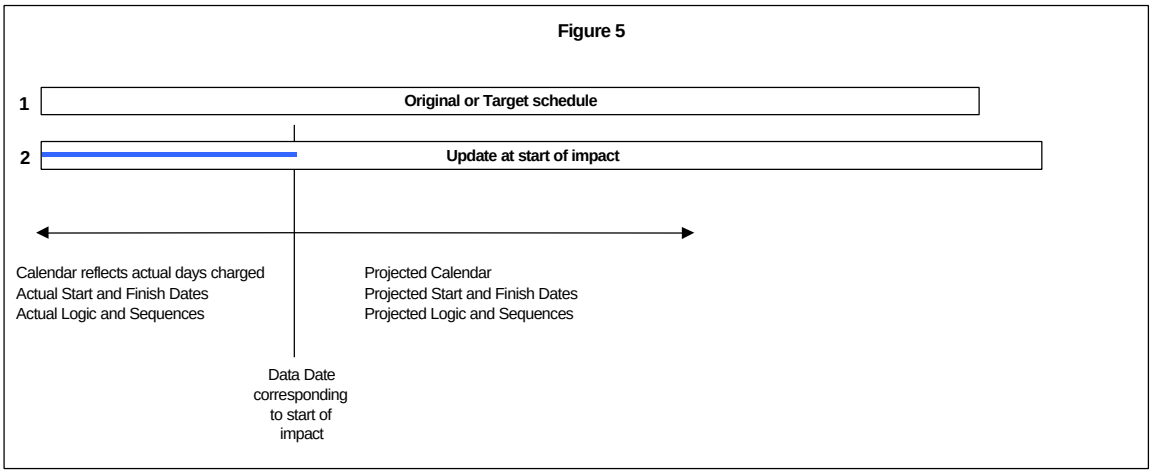
2) The scheduler may make a copy of the update right after the impact started and remove progress between the start of the impact and the data date. Creating this schedule, follow the same steps as described above with the following exceptions:

   - Copy the schedule update right after the impact began.
   - Identify the schedule activities that the Contractor worked on between the interim schedule data date and the regular monthly update date.
   - Change the actual start dates and actual finish dates back to ES or EF for the activities identified above. Change the remaining duration and/or percent complete values as needed. For activities that have not started at

all, the remaining duration should equal the original duration and the percent complete should be set to zero.

Regardless of the method selected, the newly created interim schedules should match the contractually required schedule updates in all aspects other than added or deleted progress. In other words, there should be no changes to schedule logic, no addition or deletion of activities, or no alterations to calendars or resources that would artificially affect the critical path. If the interim schedule meets these criteria, it can be used as the target schedule as detailed above.

Also, regardless of when a schedule update is created, information before the data date (to the left of the blue line on a schedule plot) shall be actual information. Activities shall have actual start and finish dates as applicable, and the actual sequences of work shall be shown. The calendars shall reflect the days the Contractor actually worked on each activity. Information after the data date (to the right of the blue line) shall be planned or predicted information. There shall be no actual start or finish dates after the data date. Also, the calendars shall reflect the predicted number of days the Contractor planned to work. These concepts are presented in Figure 5 below:
When creating a schedule update after the fact, it is important to resist the



temptation to replace planned information with actual information.

Step 2. Predict the effect of the impact on the project completion date.

This step is **mandatory for all pre-impact TIAs and all post-impact TIAs**. This step consists of creating a hypothetical schedule to predict the effect of the impact on the project completion date. This can be done by making a copy of the schedule used in Step 1, inserting an activity modeling the impact into the network, and recalculating the schedule. It may be necessary to estimate the duration of the impact. This step serves the following functions.

- It will show if the impact will affect the critical path or if float exists.

- If the impact activity has positive float, the amount of float is the amount of time that TxDOT and the Contractor have to resolve the problem before it starts delaying the project.
- This step will help the department decide if time should be suspended for the impact.
- Possibly identifying means to mitigate the impact.

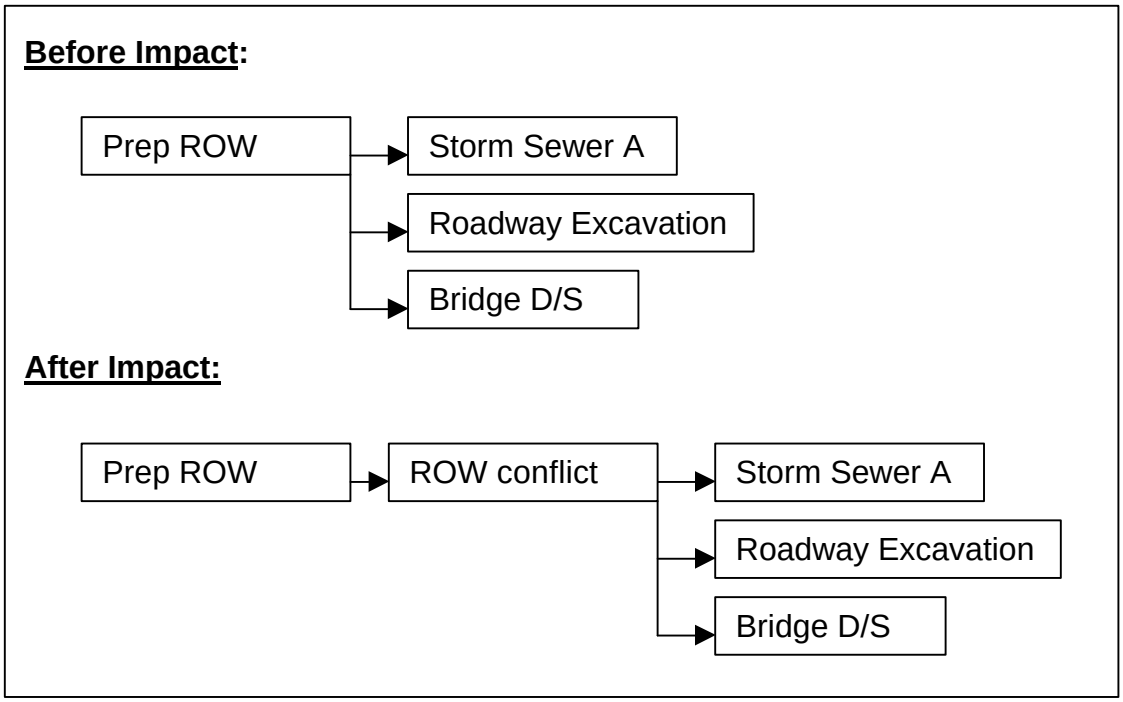
To predict the effect of the impact on the project completion date:

1) Open the schedule created in Step 1. Open a desired layout.

2) Determine where to logically insert an activity representing the impact. For activities that may be ***delayed***, it is logical to insert the impact ***before*** the affected activity. For activities that may be ***extended*** by an impact, it makes sense to insert the impact ***after*** the affected activity. Locate and highlight the desired activity.

3) Insert an activity, enter an activity ID, activity description, original duration, any coding desired, and assign the activity logical calendar ID.

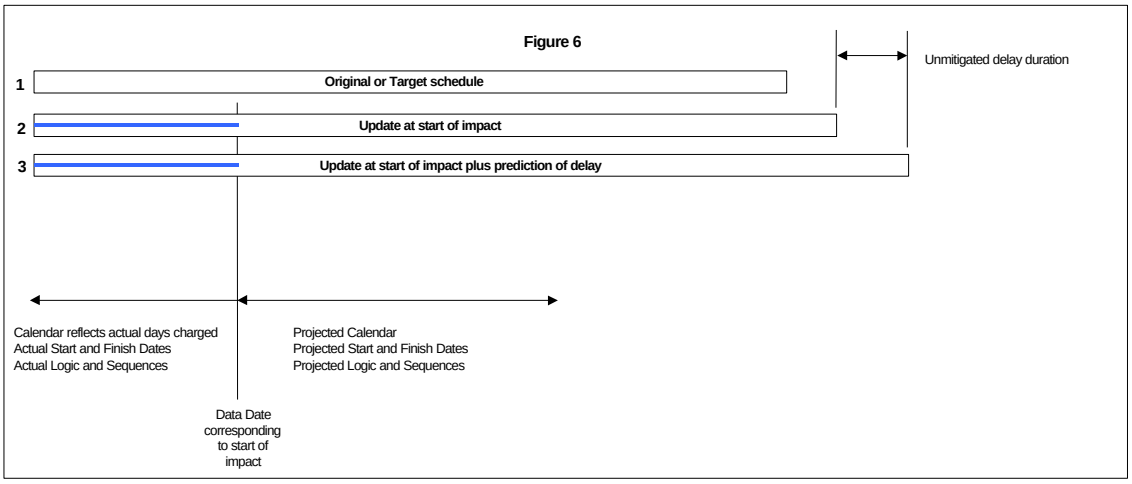
4) Add predecessors and successors. Note that the intent of this step is to see how the impact affects the schedule without any other changes in logic. It is therefore essential to add the impact without making any other changes in logic. It is recommended that for a delay type of impact that the impact be inserted between the delayed activity and all of its predecessors. For extension-type impacts, insert the impact between one predecessor and all of its successors. Regardless of where the impact is inserted, it is important to maintain the intent of the original relationships. Consider the following example:



Note that the impact is inserted into the network while maintaining the original intended sequence.

5) Recalculate the schedule and note the effect of the inserted activity on the project completion date.

The goal of this step is to create a schedule that predicts the effect of the delay if no mitigative efforts were taken by the Contractor or ordered by TxDOT. This concept is presented in Figure 6 below:



As with interim or after-the-fact schedules created in Schedule Analysis Step 1, information before the data date shall be actual start and finish dates, actual

sequences of work, and actual days worked. Information after the data date, with the exception of the predicted impact, shall be as originally planned or predicted.

If this step shows that the project will be delayed, TxDOT and the Contractor should discuss options to keep the cost of the impact as low as possible. The Contractor should be reminded that it is their implied contractual responsibility to mitigate the cost of project impacts.

The circumstances of each impact are different. In some cases, working through an impact may be the lowest cost alternative. There may be a way of resequencing the project to overcome all or part of the delay. In other cases, demobilizing and waiting for the impact to clear may be the best option. TxDOT and the Contractor should agree on the approach that minimizes the cost and effect of the impact.

Step 3. Track the status of the project during the impact.

This step is not needed for pre-impact TIAs and is optional for post-impact TIAs. If used for post-impact TIAs, this step will help to determine if changes in float force a non-critical impact to become critical. Conversely, a critical impact may become non-critical. Both scenarios are possible because of other work underway simultaneous to the impact. It may be necessary to create weekly schedule updates to keep up with multiple changes of critical status. The monitoring step will help determine if mitigating efforts are successful. For example, if the Contractor can move on to future critical activities, the impact may not delay the project. If the impact is long enough to span several months, the Contractor should prepare and submit monthly updates as usual. Extra care should be taken to ensure that the Contractor has not made any significant changes to schedule logic, added or deleted activities, or changed calendars or resources during the monitoring period.

The process of tracking the status of the project during the impact is similar to monitoring routine monthly updates. However, the following points need to be stressed:

The critical path can change from month to month. If work is progressing on multiple paths through a schedule, a critical activity may become non-critical and vice-versa. If the impact falls off the critical path, the impact may be over (recognize that the impact may still be affecting the Contractor's resources and costs, but not necessarily time).

Activities that are started but not completed may be very sensitive to the scheduler's estimate of percent complete or remaining duration. Consider an activity on the critical path with an original duration of 20 days. If this activity has started and remains critical, simply changing the percent complete value from

50% to 40% will change the remaining duration from 10 days to 12. In turn, these different estimates can change the total project duration by two days.

Closely monitor changes in sequence, logic revisions, and out of sequence work. During a long delay, it is common for a Contractor to seek non-impacted areas to keep crews and equipment productive. This generally helps TxDOT by minimizing the cost of the impact. It is possible that these mitigative efforts completely overcome the impact on the project completion date. If so, the impact may transform from a project delay to inefficiency, disruption or acceleration.

Another common reaction to a long project impact is for the Contractor to slow down work on the project or to stop work altogether. These reactions may lower the cost of the impact by eliminating crew down time at the expense of increasing project delay costs. The Contractor should be cautious in this reaction, however, because the department may view these actions as changing the impact from an excusable and compensable to a perceived Contractor delay.

Step 4. After the impact is over, determine the status of the project and compare it to the status before the impact began.

This step is not needed for pre-impact TIAs but is **mandatory for post-impact TIAs**. Remember that this step cannot be performed until the impact is over and should not be performed until both parties agree that the impact is over.

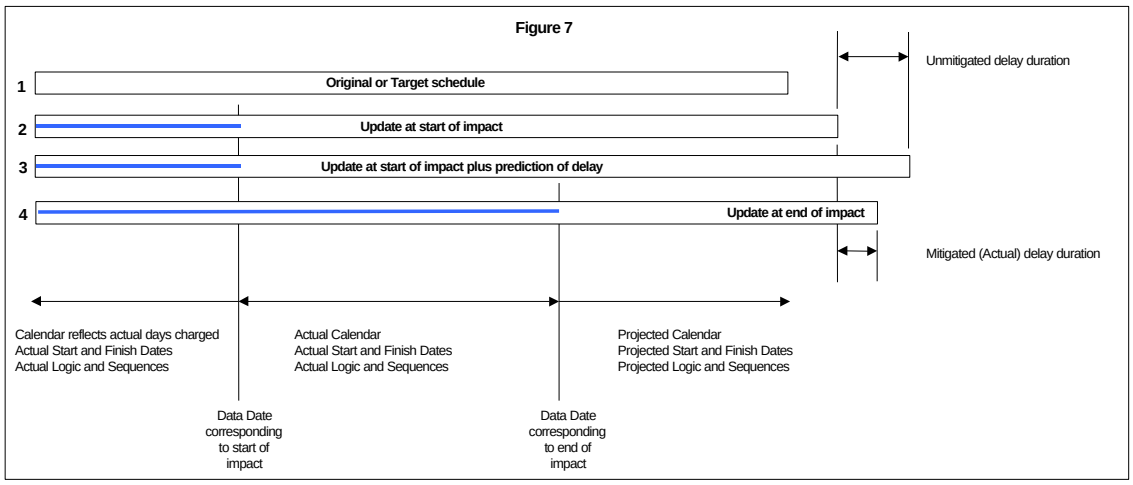
If the project completion date is now later than the completion date calculated in Step 1, the project has been delayed. If not, the project has not been delayed. If the impact ends on any day other than the normal update date, it t may be necessary to create an interim schedule as described in Step 1. It is very important to verify that the impact originally assumed to cause a delay was the actual cause of the delay.

Several factors may complicate the basic process described above. First and foremost, there may be no updated schedules available. This sad reality may prevent a Contractor from demonstrating a legitimate impact. On the other hand, the lack of schedule updates may mean the Contractor can falsely show entitlement to an inflated period. Either way, the lack of an original schedule or accurate monthly updates can slow down the dispute resolution process. It can lead to old positional negotiation strategy that can only resolve problems when one party browbeats the other into submission. Ultimately, the lack of scheduling can lead to the degradation of the relationship between TxDOT and Contractor.

Assuming updates are available, one may discover several impacts running concurrently or partially concurrently. If the impacts are not all the same category (for example, the first impact is excusable and compensable, and the second impact is excusable but non-compensable), it may be impossible to separate the effect of the two impacts. In these cases, it is helpful to develop an

interim schedule at the point where the second impact becomes controlling to isolate these impacts. Third, the schedule may have been revised during an impact. This combination of events makes it difficult if not impossible to separate the affect of the impact from the schedule revision. This practice should be avoided if at all possible.

Once this schedule has been created, it is possible to determine the overall effect of the impact on the project schedule. The relation between the schedules created and used for this analysis is presented in Figure 7 below:



Note that it is possible that the actual delay may be greater than the predicted delay. This may occur if there are no opportunities to mitigate the delay or if the delay duration is greater than predicted. It could also be that the weather was worse than predicted, thereby intermingling the effects of weather with the effect of the delay.

Schedule Analysis Summary

Note that all four steps cannot be performed until the impact is over. For project delays, disruptions, inefficiencies and accelerations, it is advisable to perform a post-impact TIA. For other impacts, such as predicting the effect of a change order on the project schedule, a pre-impact TIA may suffice.

CPM Schedule Review Checklist for Original Schedules

CSJ:		**County**:	
Project:		**Highway**:	
Contractor:		**Sched. Name**	

Yes	No	NA	Item
			Has the Contractor submitted a disk in accordance with time frames in special provision?
			Is the schedule submitted in specified format?
			Full CPM ____ Basic CPM ____
			Is the schedule compatible with Primavera Project Planner or SureTrak as required?
			Has the Contractor identified a qualified Project Scheduler?
			Are all activity durations less than 20 working days?
			If not, are exceptions acceptable?
			Does the schedule follow the planned Traffic Control Plan?
			If not, has the Contractor submitted a written request to change TCP?
			Is the project completion date within allowed number of working days and months?
			Days Allowed ____ Months Allowed ____
			Days Required ____ Months Required ____
			Has the Contractor included resource loading if required?
			Is/are critical path(s) clearly discernible and accurately identified?
			Is all contract work included?
			Are activity durations reasonable for amount and complexity of work?
			Are activity descriptions clear and unambiguous?
			Is schedule free of major blunders?
			Other than start and finish activities, do all activities have predecessors and successors?
			Is the level of detail appropriate for complexity of project?
			Is there no imposed finish date?
			Is the use of constraints kept to a minimum?
			Are logical calendars set up?
			Are the calendars reasonable (i.e. not overly optimistic) and is weather considered?
			Are major holidays set up as non-work days?
			Do activities use appropriate calendars?
			Is a logical coding structure set up?
			Are activities properly coded?
			Can the schedule be organized logically using the coding structure?

Schedule acceptable according to specifications? Yes ☐ No ☐ Reasons documented above

Date: **Reviewer**:

Note: The Engineer's review and acceptance of the Contractor's Project Schedule does not relieve the Contractor of any of its responsibility for the project schedule, or of the Contractor's ability to meet interim milestone dates (if specified) and the contract completion date, nor does such review and acceptance expressly or by implication warrant, acknowledge or admit the reasonableness of the logic, durations, manpower or equipment loading of the Contractor's project schedule.

Project Schedule Status Report

Project:		**County:**	
CSJ:		**Contractor:**	

Schedule Name	Data Date	Completion Date	Working Days	Calendar Days		Working Days		TxDOT Loss		Explanation for Loss/Gain
				Period Gain/Loss	Cumulative Gain/Loss	Period Gain/Loss	Cumulative Gain/Loss	Calendar Days	Working Days	

Definitions:

Schedule Name: The unique filename assigned to the original schedule, updates and revisions.

Data Date: The calendar date when the project has been updated and the network revised, statussed or progressed.

Completion Date: The unconstrained, unrestricted calculated project completion date as calculated by Primavera Project Planner (P3).

Working Days: Calculated by P3 using a hammock activity and with an updated calendar reflecting actual time charges.

Period Loss/Gain: The number of calendar days or working days the project completion date has been delayed (positive figures) or accelerated in current period.

Cumulative Loss/Gain: The total number of calendar days or working days the project completion date has been delayed or accelerated since the original schedule.

TxDOT Loss: Enter the number of calendar days and working days of delay attributable to TxDOT impacts.

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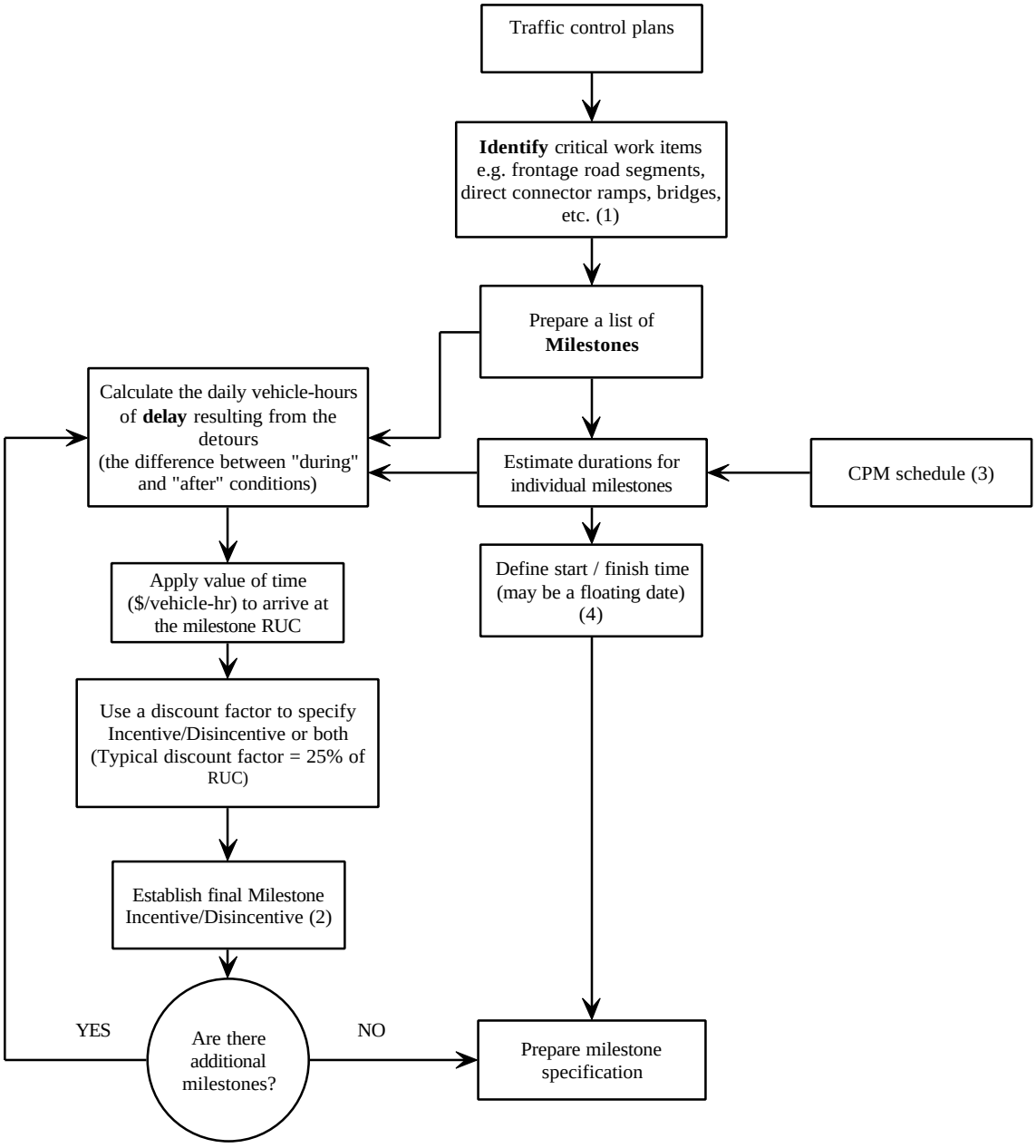
Milestones

Procedural Flowchart for Developing Milestones Specification



Notes:

(1) Milestones are a useful tool to control the progress of individual work-tasks and/or phases on a long-duration project.

Pros:

- By specifying appropriately spaced intermediate milestones the Engineer can exercise control over the pace of progress on a project.
- They can be used as an effective strategy to mitigate the adverse impacts of construction on mobility and access by limiting the duration (using incentives and/or disincentives) of disruption in high road user impact areas.

Cons:

- If too many milestones are specified on a low bid project the cost of the project may increase.
- If high liquidated damages are associated with milestones and time-determination for specifying milestone duration is not accurate, it may lead to disputes.

Cost:

- The cost of incentives assigned to milestones.
- The resources needed to prepare the milestone specification.

(2) Incentives may be provided for individual milestones when expediting work on them will yield improved mobility and access but will cost the contractor additional resources.

(3) Other techniques for calculating duration can be used.

(4) Floating dates are used to provide maximum flexibility to the contractor in choosing the start date for those milestones that are expected to be disruptive to the traffic, e.g., demolish and construct xyz ramp. The duration of the "window" is specified in the specifications. Liquidated damages and/or incentives are used to minimize and/or expedite work on these milestones.

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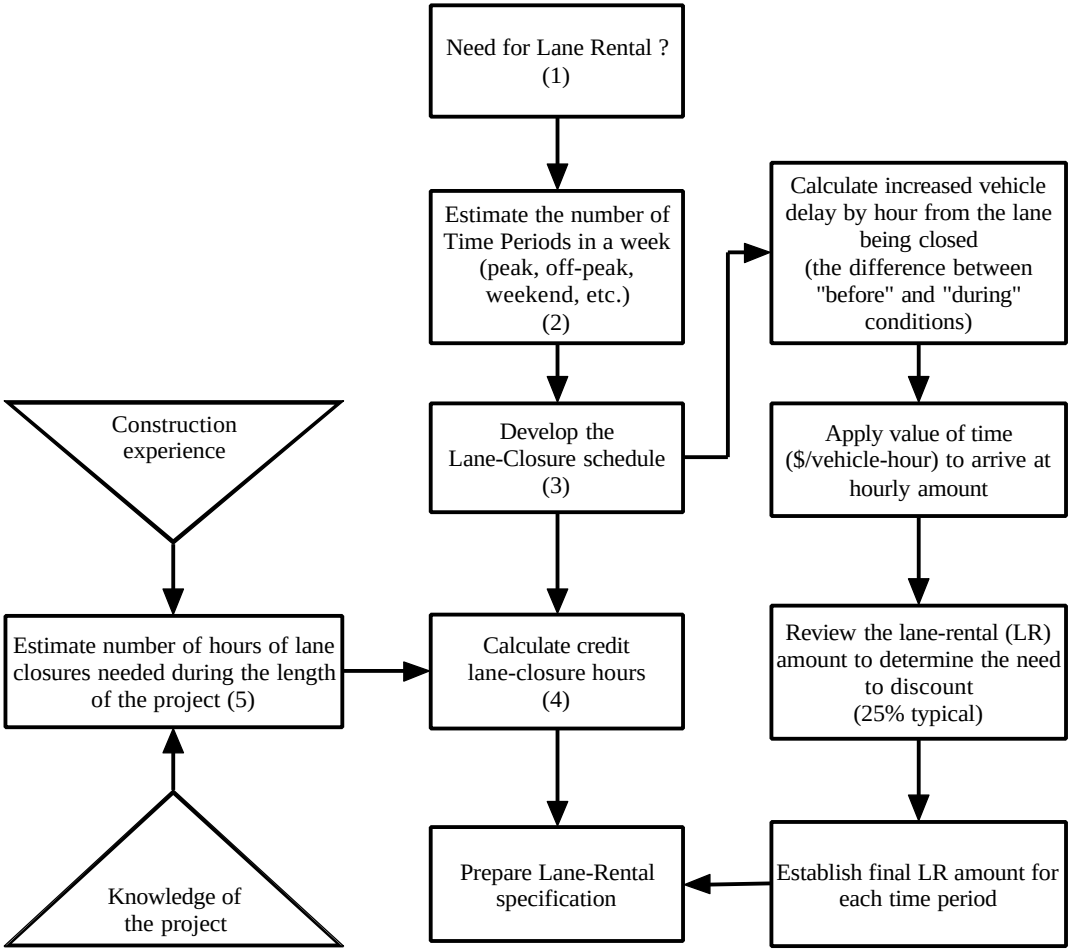
Lane Rental Disincentive

Procedural Flowchart for Preparing Lane Rental Specification



Notes:

(1) Lane Rental

The lane rental technique is useful for urban roadway reconstruction projects where the level of congestion necessitates an incentive to minimize the number and duration of intermittent lane-closures.

Pros:

- Provides a financial incentive to the contractor to be more efficient with "lane-closures".
- Use one lane-closure to schedule multiple subs and/or work items.
- Enhances mobility through work zone.

Cons:

- Safety concerns (contractor may opt to provide a single lane-closure instead of a double lane-closure.)
- May lead to more nighttime work.
- The additional responsibility of keeping track of lane-closures and their duration.
- An accurate estimate of the lane-closures needed during the design phase to estimate credit lane-closure hours.

Costs:

- The initial bid cost is going to be higher than a similar project with no lane-rental, since the contractor must include the cost of lane-rental in his bid. However, this added cost should be credited back to the State as lane-rental charges accrue.
- The cost of calculating road user costs and lane-rental rates.

(2) The number of time periods is based on traffic-volume variations during a week. Typically a week may be divided into three or four time periods, i.e. peak period, weekday off-peak, nights or low volume, weekend off-peak, etc. Different lane-rental rates may be specified for each time period. **Alternatively, lane-rental may only be used for peak-hour periods**. A sample lane-rental table is attached in Reference 1. It shows the lane-rental rates used on the Dallas HighFive Project.

(3) The lane-closure schedule is a graphical representation of the time-periods. A sample is attached in Reference 2.

(4) The credit lane-closure hours may be used to offset the increase in bid price due to lane-rental specification. Typically, 25% of the estimated total lane-closure hours may be provided as credit hours to the contractor. This number may be adjusted based on the requirements.

(5) Include only those lane-closures that are not shown in the plans. Permanent (or long-term) lane-closures that are shown in the Traffic Control Plans may not be counted in the chargeable lane-closures.

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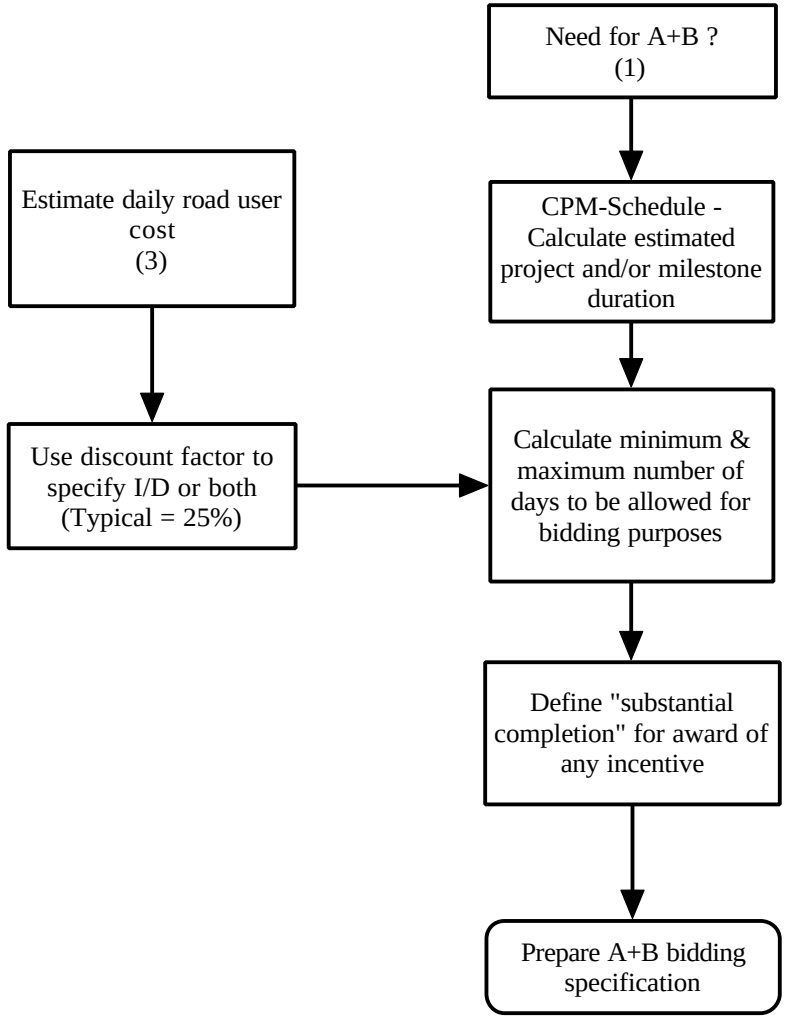
A+B Provisions

Procedural Flowchart for Preparing A+B Specification



Notes:

(1) Are road user impacts high enough to justify the use of A+B bidding?
There must be no potential for utility or ROW conflicts on the project
The plans must be of high quality.

Pros:

- Provides a financial incentive for the contractor to accelerate the schedule.
- Minimizes construction time.

Cons:

- Nighttime work and accelerated work may raise quality and safety concerns.
- Disproportionate I/D or time-estimates can lead to mathematically unbalanced bids.

Costs:

- Cost of incentive.
- Costs associated with accelerated construction.

(2) For budgeting – assume full payment of any incentive. Verify that construction cost + maximum incentive can be budgeted for the project

Minimum number of days reduces opportunity for unbalancing bid.

(3) The process for calculating road user costs is shown in the flow-charts titled:

Calculation of Road User Costs for Substantial Completion Incentives/Disincentives (I/D): Added-Capacity Projects

OR

Calculation of Road User Costs for Substantial Completion Incentives/Disincentives (I/D): Projects Not Adding Capacity

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RUC Additional Information

General Information on
Calculation of Construction-Related Road User Costs (RUC)

Flow Charts for Determining RUC

The attached flow charts provide general maps of the process for determining road user costs for different types of accelerated construction strategies (per November 8, 2001 TxDOT memorandum on "Accelerated Construction"):

- Milestones with I/D
- Substantial Completion I/D for Added-Capacity Project
- Substantial Completion I/D for Projects Not Adding Capacity (eg., rehabilitation, bridge replacement)
- Lane Rental

Techniques for Determining RUC with Examples

The specific techniques for calculating road user cost values are presented in attached Table 1. The type and complexity of the project influences the analytical technique used. Some examples have also been attached, illustrating how to determine daily RUC for the various project categories defined in Table 1.

Values of Time used in RUC calculations

The values of time used in RUC calculations are adjusted annually by the Construction Division. The most recent values, per March 2001 TxDOT memorandum, are provided below.

	Passenger Cars	Trucks
Per person	$12.99	$21.87
Per vehicle	$16.24 (at 1.25 passengers per vehicle)	$21.87

Road user costs are typically calculated on a vehicular basis using passenger car volumes. However, if data are available on vehicle occupancy rates, or if the project involves high volumes of buses or other high-occupancy vehicles, the per person rates may be used accordingly. If truck volumes are high, truck values of time should be factored into the calculations for the number of trucks impacted.

Resources for Assistance with Determining RUC

Two documents listed below were developed by TTI for TxDOT and detail methods for determining road user costs:

1. "Techniques for Manually Estimating Road User Costs Associated with Construction Projects," available at ftp://ftp.dot.state.tx.us/pub/txdot-info/cmd/407730.pdf or http://tts-web/docs/reports/7/ms-7651.htm
2. "A Short Course on Techniques for Determining Construction Related Road User Costs."

For projects in Categories III and IV on Table 1, the RUC tables found in the report, "Techniques for Manually Estimating Road User Costs Associated with Construction Projects," **may** be the appropriate tool for determining RUC values. Please be advised that the tables in the report are representative for projects conforming to the characteristics and input variables specified in the study.

If an accelerated construction strategy is chosen that will require determining RUC, district staff may perform the calculations or seek assistance from the divisions. Until both district and division staff become more experienced with performing calculations involving computer simulation models, other options are available to the districts. One option would be for the district to set up one or more evergreen contracts utilizing pre-certified firms (Group 7, Category 7.1.1, "Traffic Engineering Studies") to handle project specific needs. If the PS&E is being prepared under a consultant contract, then the consultant would be a source for computing road user costs and preparing the corresponding provisions. Technical assistance with applications of road user cost calculation methods may also be obtained from the TTI urban offices.

Division Contacts:

- TRF-TE Field Area, Meg Moore, Charles Koonce
-
-
-
-

TTI Urban Offices:

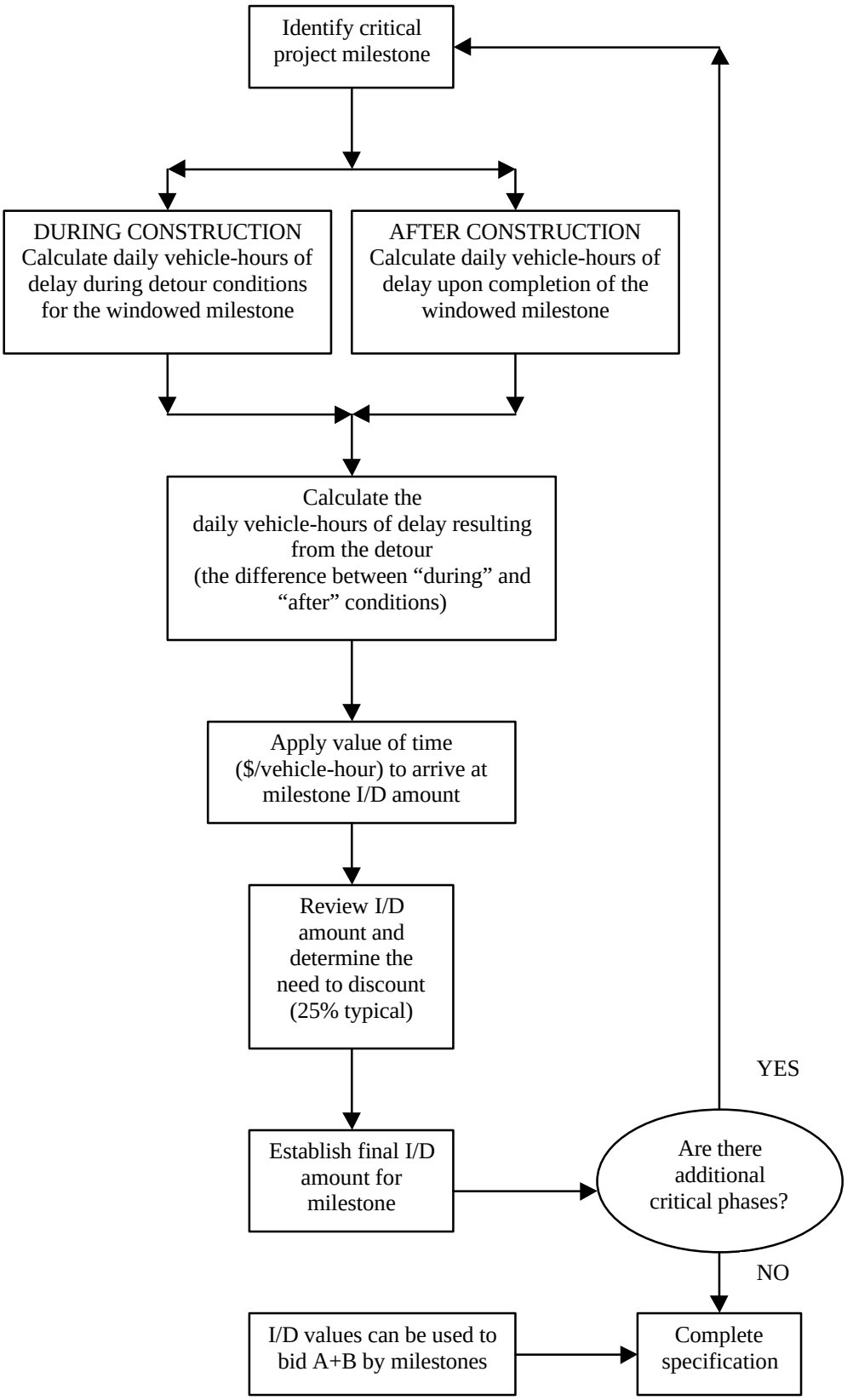
- Austin Office (512) 467-0946
- Arlington Office (817) 277-5503
- Houston Office (713) 686-2971
- San Antonio Office (210) 731-9938

Table 1. Categories of Candidate Projects For Application of RUC

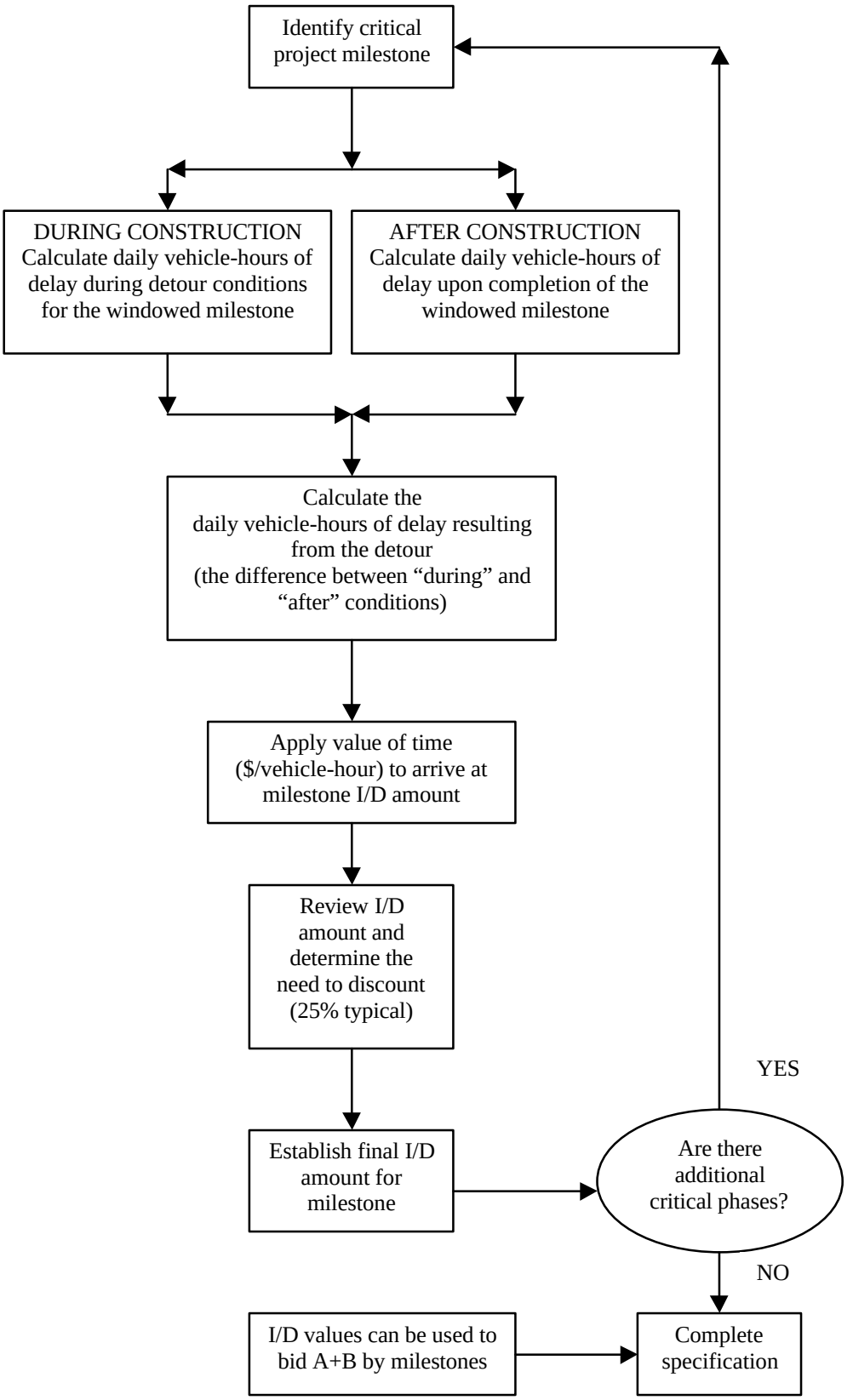
Category	Description of Projects	Setting	Technique	Reference Guide
I	**High Impact Urban Freeway Construction or Rehabilitation** • Severe capacity reduction during construction • Phase completion time critical • Interaction with other freeway or arterial projects	Urban	FREQ, CORSIM or HCS models	1
II	**Urban Arterial Roadways** • Signalized intersections • Diamond interchanges	Urban	PASSER models	1
III	**Other Added Capacity Projects** • Highway widening projects not classified as I or II above (rural highways, suburban arterials, urban freeways) • New facility construction	Urban or Rural	Manual Technique	1 and 2
IV	**Rehabilitation and Other Non-Capacity-Added Projects** • Paving projects (no capacity increase) • Bridge replacements • Detour routing	Urban or Rural	Manual Technique	1 and 2

Reference 1: *A Short Course on Techniques for Determining Construction Related Road User Costs*
Reference 2: *Techniques For Manually Estimating Road User Costs Associated With Construction Projects*

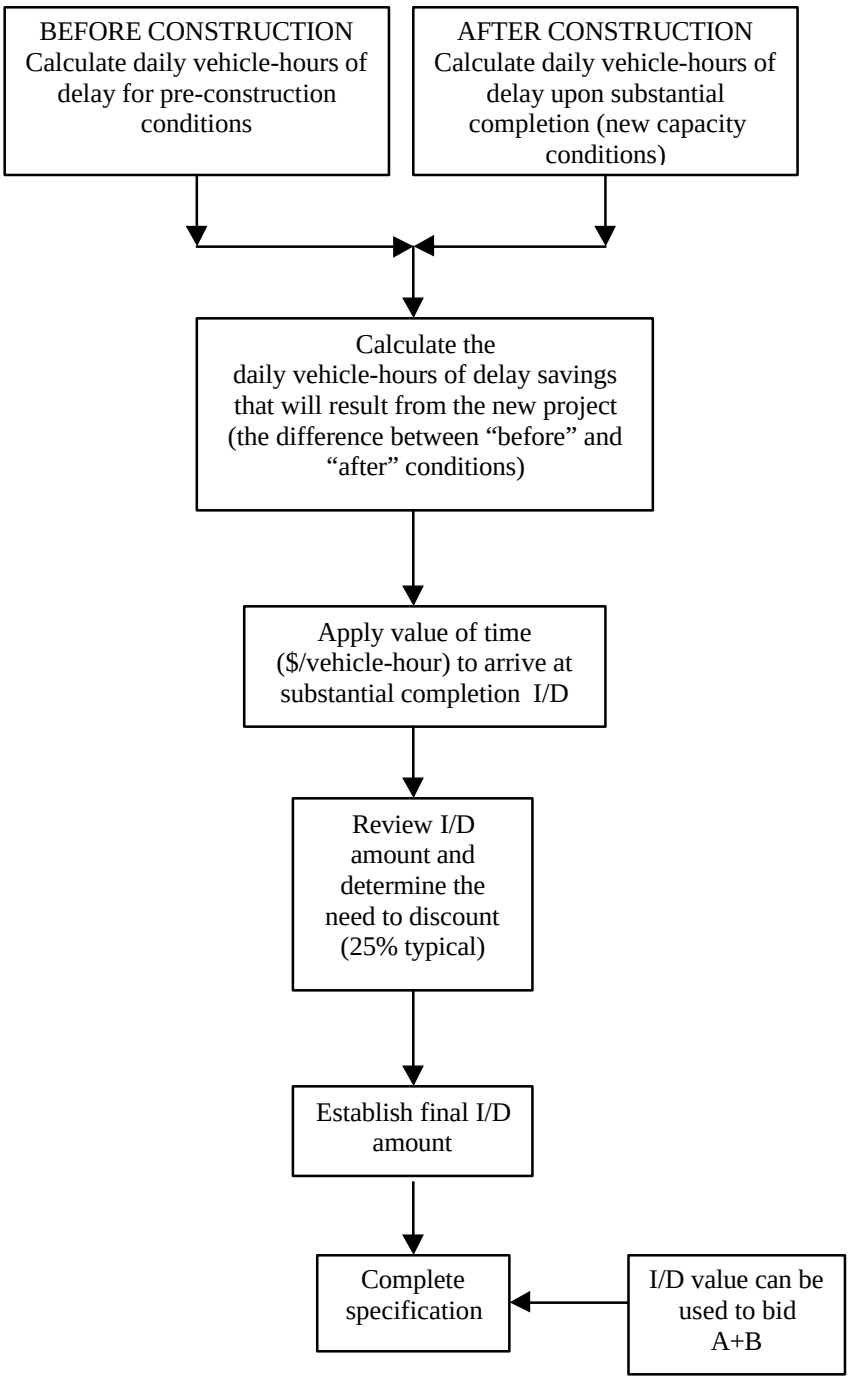
Calculation of Road User Costs for
Milestones with Incentives/Disincentives (I/D)



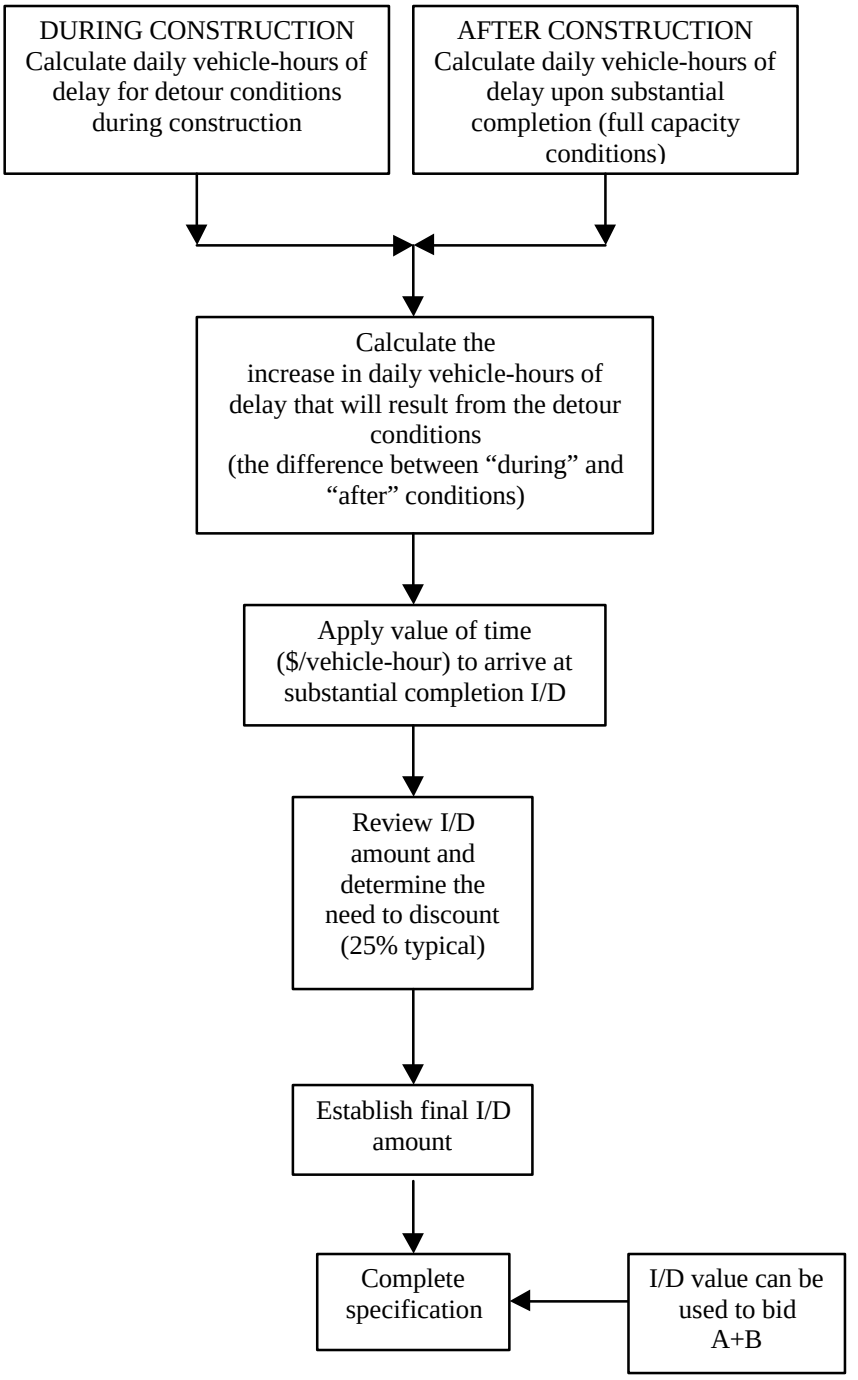
Calculation of Road User Costs for
Milestones with Incentives/Disincentives (I/D)



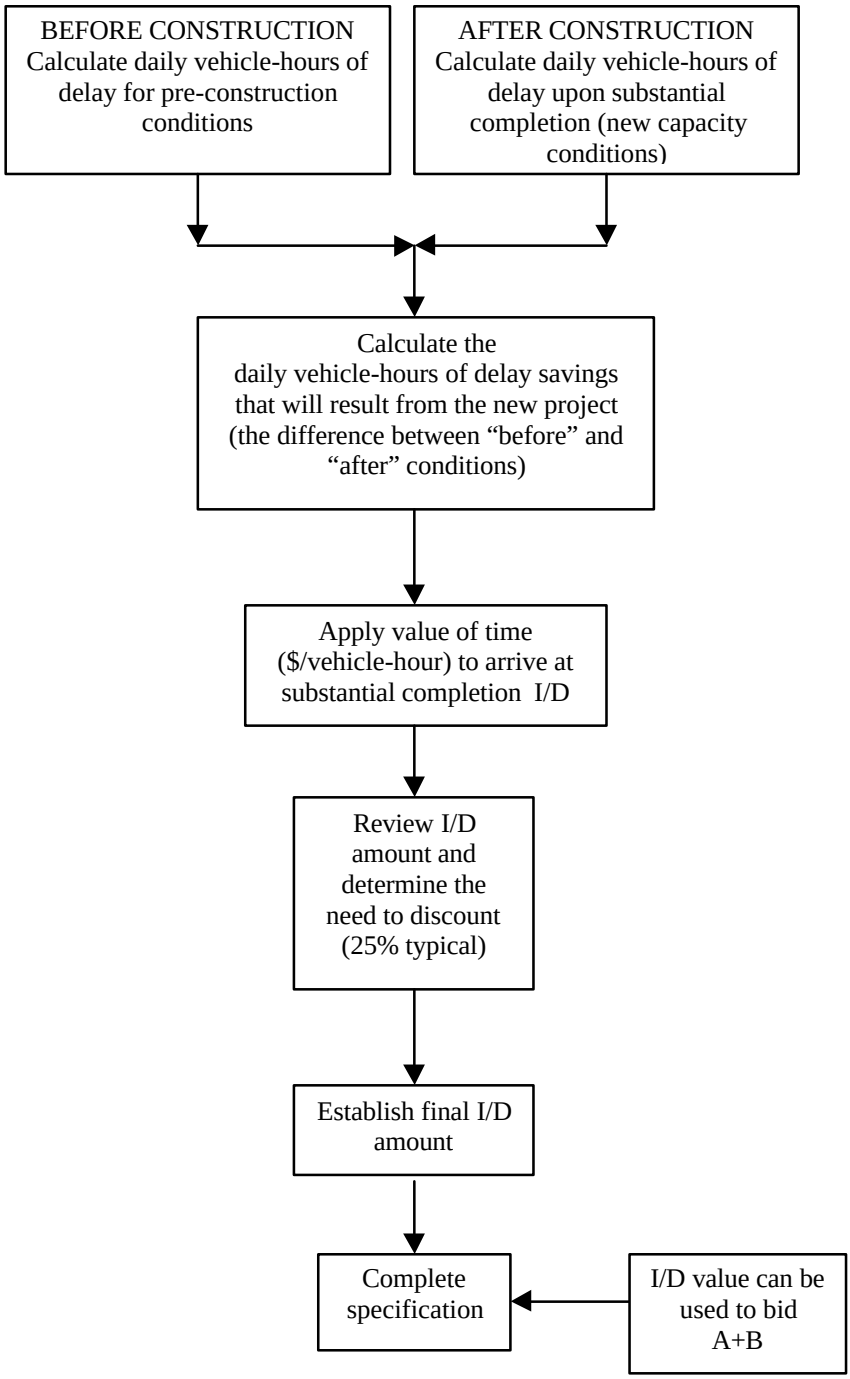
Calculation of Road User Costs for
Substantial Completion Incentives/Disincentives (I/D)
Added-Capacity Projects



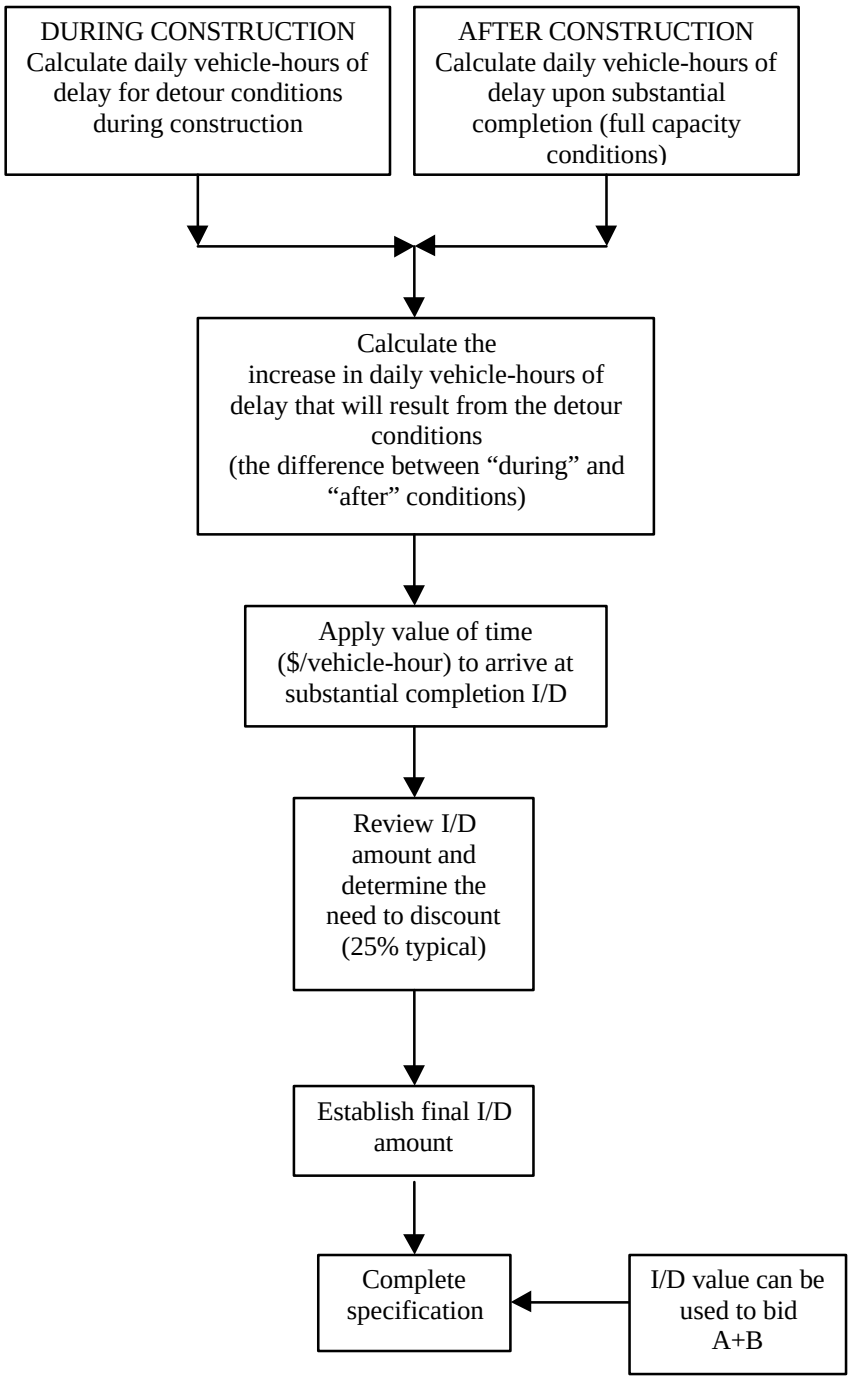
Calculation of Road User Costs for
Substantial Completion Incentives/Disincentives (I/D)
Projects Not Adding Capacity



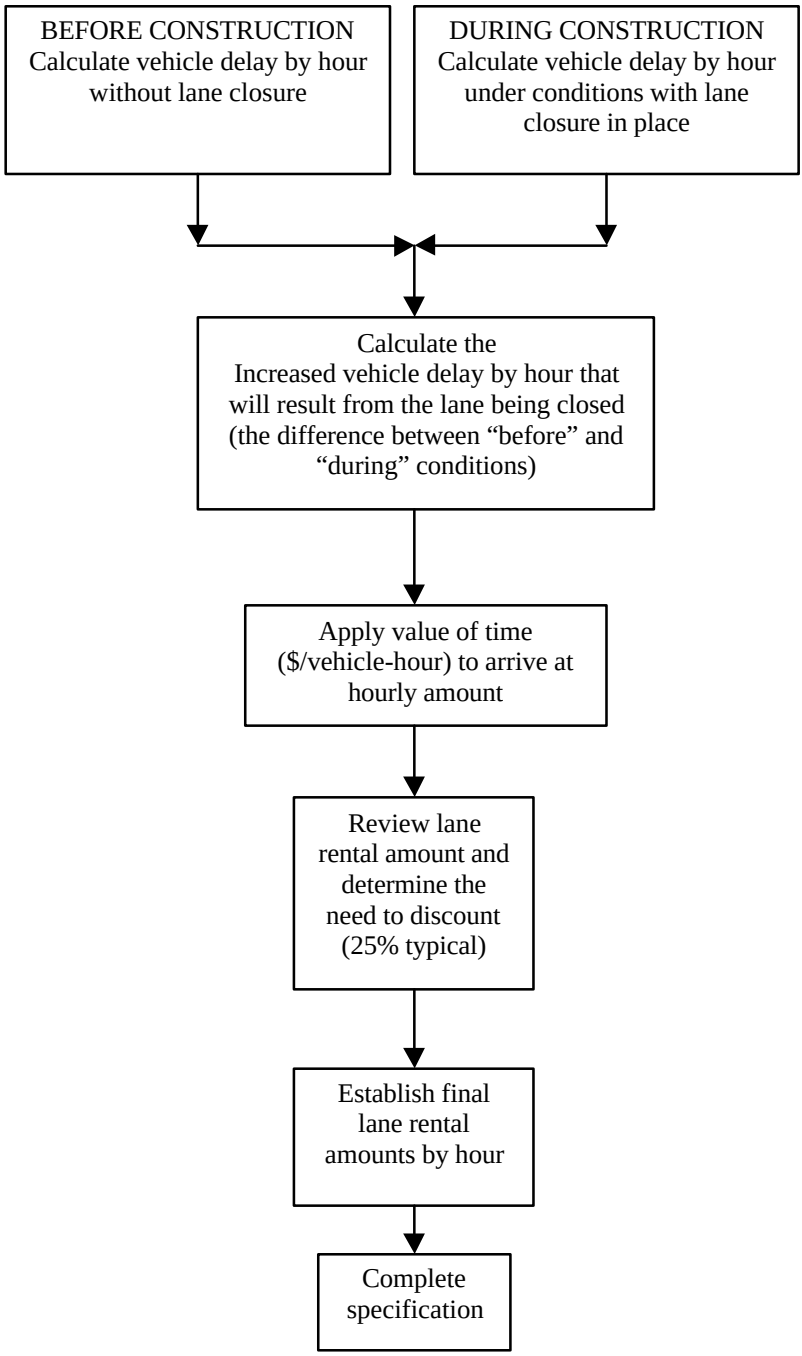
Calculation of Road User Costs for
Substantial Completion Incentives/Disincentives (I/D)
Added-Capacity Projects



Calculation of Road User Costs for
Substantial Completion Incentives/Disincentives (I/D)
Projects Not Adding Capacity



Calculation of Road User Costs for Lane Rental



Texas Department of Transportation

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Title: Techniques for Manually Estimating Road User Costs Associated with Construction Projects

File Location: MS-7651

Author: Daniels G, Ellis DR, Stockton WR

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Abstract: Road user costs (RUC) in Texas have been applied predominantly on high-profile urban freeway reconstruction projects, which are ideal candidates for RUC application because of the potential for very high motorist delay costs. The July 1998 guidelines provided by TxDOT suggest that all projects that add capacity should be considered for RUC. This applies to a much wider range of projects. Not all potential projects, however, are as complicated as urban freeway reconstruction efforts that require detailed simulation modeling to determine the value of RUC.

The objectives of this research study are: 1) to develop a manual technique for determining road user costs (RUC) for typical added-capacity and highway rehabilitation projects; 2) to develop implementation guidelines that define the appropriate technique, given the project type, for calculating RUC and determining the ultimate value to be used for contracting purposes; 3) to review and evaluate the value of time used by TxDOT in determining delay savings and recommend appropriate values to use in RUC calculations; and 4) to review and evaluate the practice of discounting of RUC values to 25 percent.

Texas Department of Transportation

Precertified Firm Information

Listing of Precertified Firms - Sorted by Firm Name

TxDOT District Abbreviations and Names

Each provider and subprovider select the desired areas/locations in which they wish to do business with TxDOT. These areas could be statewide or selected TxDOT districts. These districts are:

ABL	Abilene	**AMA**	Amarillo	**ATL**	Atlanta	**AUS**	Austin
BMT	Beaumont	**BWD**	Brownwood	**BRY**	Bryan	**CHS**	Childress
CRP	Corpus Christi	**DAL**	Dallas	**ELP**	El Paso	**FTW**	Fort Worth
HOU	Houston	**LRD**	Laredo	**LBB**	Lubbock	**LFK**	Lufkin
ODA	Odessa	**PAR**	Paris	**PHR**	Pharr	**SJT**	San Angelo
SAT	San Antonio	**TYL**	Tyler	**WAC**	Waco	**WFS**	Wichita Falls
YKM	Yoakum						

Working Categories

Texas Department of Transportation (TxDOT) precertifies providers and subproviders in the following working categories. These categories are:

1.1.1	Policy Planning
1.2.1	Systems Planning
1.3.1	Subarea/Corridor Planning
1.4.1	Land Planning/Engineering
1.5.1	Feasibility Studies
1.6.1	Major Investment Studies
2.1.1	Traffic Noise Analysis
2.2.1	Air Quality Analysis
2.3.1	Wetland Delineation
2.4.1	Nationwide Permit
2.4.2	Individual Permits
2.4.3	U.S. Coast G. & U.S. Army Corps Of Engr. Permits

2.5.1	Water Pollution Abatement Plan
2.6.1	Protected Species Determination (Habitat)
2.6.2	Impact Evaluation Assessments
2.6.3	Biological Surveys
2.7.1	Sec. 4(F)\6(F) Evaluations
2.8.1	Surveys, Res. & Doc. Of Historic Build, Struct. And Objects
2.9.1	Historic Architecture
2.10.1	Archaeological Surveys
2.11.1	Historical And Archival Research
2.12.1	Socio-Economic And Environmental Justice Analyses
2.13.1	Hazardous Materials Initial Site Assessment
2.14.1	Environmental Document Preparation
3.1.1	Route Studies & Schematic Design - Minor Roadways
3.2.1	Route Studies & Schematic Design - Major Roadways
3.3.1	Route Studies & Schematic Design - Complex Highways
3.4.1	Minor Bridge Layouts
3.5.1	Major Bridge Layouts
3.6.1	Multi-Level Interchange And Exotic Bridge Layout
4.1.1	Minor Roadway Design
4.2.1	Major Roadway Design
4.3.1	Complex Highway Design
4.4.1	Major Freeway Interchanges And Direct Connectors
5.1.1	Minor Bridge Design
5.2.1	Major Bridge Design
5.3.1	Multi-Level Interchange Design
5.4.1	Exotic Bridge Design
6.1.1	Routine Bridge Inspection
6.2.1	Complex Bridge Inspection
7.1.1	Traffic Engineering Studies
7.2.1	Highway-Rail Grade Crossing Studies
7.3.1	Traffic Signal Timing
7.4.1	Traffic Control Systems Analysis, Design And Implementation
7.5.1	Intelligent Transportation Systems
8.1.1	Signing, Pavement Marking And Channelization
8.2.1	Illumination
8.3.1	Signalization
8.4.1	Its Control Systems Analysis, Design & Implementation

8.5.1	Highway-Rail Grade Crossings
9.1.1	Bicycle And Pedestrain Facility Development
10.1.1	Hydrologic Studies
10.2.1	Basic Hydraulic Design
10.3.1	Complex Hydraulic Design
10.4.1	Pump Stations-Hydraulics
10.4.2	Pump Stations-Electrical
10.4.3	Pump Stations-Structures
10.5.1	Bridge Scour Evaluations And Analysis
11.1.1	Roadway Construction Management And Inspection
11.2.1	Major Bridge Construction Management And Inspection
12.1.1	Asphaltic Concrete
12.1.2	Portland Cement Concrete
12.2.1	Plant Inspection And Testing
14.1.1	Soil Exploration
14.2.1	Geotechnical Testing
14.3.1	Transportation Foundation Studies
14.4.1	Building Foundation Studies
15.1.1	Survey
15.1.2	Parcel Plats
15.1.3	Legal Descriptions
15.1.4	Right Of Way Maps
15.2.1	Design and Construction Survey
15.3.1	Aerial Mapping
15.4.1	Horizontal And Vertical Control For Aerial Mapping
15.5.1	State Land Surveying
16.1.1	Architecture (Buildings)
18.1.1	Value Engineering
18.2.1	Subsurface Utility Engineering

Updated: April 12, 2001

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EXAMPLE
Substantial Completion or Milestone I/D Road User Costs
Category III Project Using RUC Tables

Two-Lane Rural Highway (0-25% No Passing Zones) (in $/day per mile				
ADT	5% trucks	10% trucks	15% trucks	20% trucks
5000	1400	1400	1500	1500
7500	2100	2200	2200	2300
10000	2800	2900	3000	3100
12500	3600	3700	3800	3900
15000	4400	4500	4600	4700
17500	5200	5300	5500	5600
20000	6000	6200	6400	6500
22500	7000	7200	7400	7500
25000	8000	8300	8500	8700
27500	9300	9600	9800	10100
30000	10700	11000	11200	11500
32500	12300	12600	12900	13200
35000	14000	14400	14800	15200
37500	16100	16500	16900	17400
40000	18300	18800	19300	19800
42500	20700	21200	21800	22400
45000	23300	24000	34600	25200
47500	26000	26700	27400	28100
50000	28800	29600	30300	31100

Four-Lane Rural Divided Highway (in $/day per mile)				
ADT	5% trucks	10% trucks	15% trucks	20% trucks
5000	1400	1400	1500	1500
7500	2100	2100	2200	2300
10000	2800	2900	3000	3000
12500	3500	3600	3700	3800
15000	4200	4300	4500	4600
17500	4900	5100	5200	5300
20000	5700	5800	6000	6100
22500	6400	6600	6700	6900
25000	7100	7300	7500	7700
27500	7900	8100	8300	8500
30000	8700	8900	9100	9400
32500	9400	9700	9900	10200
35000	10200	10500	10800	11000
37500	11000	11300	11600	11900
40000	11800	12200	12500	12800
42500	12700	13000	13400	13700
45000	13500	13900	14300	14600
47500	14500	14900	15300	15600
50000	15400	15800	16300	16700

Problem: A proposed project involves the upgrade of 1.5 miles of a two-lane rural highway to a four-lane divided highway. The proposed project will have an average daily traffic (ADT) volume of 25,000 vehicles per day and 15% trucks.

Solution:

Existing condition:	Road user costs are	$8,500/day/mile
Proposed condition:	Road user costs are	$7,500/day/mile
	Difference	$1,000/day/mile X 1.5 mi

Costs of motorist delay for each day the project is delayed: $1,500 per day

Note: RUC Tables for Category III and IV projects can be found in TTI Research Report, "Techniques for Manually Estimating Road User Costs Associated with Construction Projects." http://tti.tamu.edu/product/catalog/reports/407730.pdf

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Added Capacity

Beginning of linked document:

Reha bilitation Project

EXAMPLE
Substantial Completion or Milestone I/D Road User Costs
Category IV Project Using RUC Tables

Work Zone on a Four-Lane Rural Divided Arterial - 10% Trucks (in $/day per mile)			
One Lane Closed in One Direction		Four Lanes with Reduced Capacity	
ADT	Road User Costs	ADT	Road User Costs
5000	0	5000	0
10000	0	10000	0
15000	100	15000	0
20000	200	20000	0
25000	600	25000	100
30000	1,400	30000	100
35000	2,600	35000	200
40000	4,300	40000	400
45000	6,200	45000	700
50000	8,300	50000	1,300
55000	10,300	55000	1,800
60000	12,500	60000	2,500
65000	14,600	65000	3,400
70000	16,600	70000	4,500
75000	18,500	75000	5,600
80000	20,200	80000	6,800

Problem:

On a four-lane rural highway with an ADT of 45,000 and 10% truck volume, a two-mile rehabilitation project is proposed in which four lanes will still remain open to traffic but capacity will be restricted.

Solution:

Road user cost from the table: $700/day

Note: RUC Tables for Category III and IV projects can be found in TTI Research Report, "Techniques for Manually Estimating Road User Costs Associated with Construction Projects."

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IH-410 In San Antonio

EXAMPLE
Substantial Completion or Milestone I/D Road User Costs
Category I Project Using Simulation Model

Summary of Daily Road User Costs Analysis – IH-410, San Antonio (From Callaghan Road to Fredericksburg Road)

A CORSIM analysis of IH-410 (from Callaghan Road to Fredericksburg Road) was performed during the p.m. peak hour. The main lanes, entrance and exit ramps, as well as the frontage roads were modeled for both eastbound and westbound IH-410. First, the existing geometry was input into CORSIM. Thus, and existing CORSIM model was developed so that it could be used as a baseline for comparison. There was one alternative analyzed, this alternative involved closing the Babcock entrance ramp to IH-410 Eastbound and rerouting the traffic through the Callaghan interchange and the Fredericksburg interchange. There are approximately 1,000 vehicles using this entrance ramp, it was assumed that 600 of the 1,000 vehicles would use the Callaghan interchange, and access IH-410 via the Callaghan entrance ramp. The traffic signal at the Callaghan interchange was optimized using PASSER III-98 software to accommodate the additional traffic volume. The remaining 400 vehicles would traverse through the Fredericksburg interchange and find other means to access IH-410 Eastbound. PASSER III-98 was once again used to optimize the signal timings at Fredericksburg Road. The table below provides a summary of the results of the CORSIM modeling effort.

Summary of Daily Road User Costs – IH-410, San Antonio

Stage of Construction	Delay (veh-hrs/hr)[1]	Daily Road User Cost[2]	Daily Cost x 0.25[3]	Adjusted Daily Cost[4]	Cost Difference
Existing	400	$44,800	$11,200	$14,560	-
Alternative I	425	$47,600	$11,900	$15,470	$910

[1] The peak-hour delay experienced by vehicles traveling in the network.

[2] The estimated daily road user cost assuming a multiplying factor of eight (8) hours per day and a value of time = $14/hr.

[3] The total daily road user cost adjusted by a factor of 0.25 as outlined in suggested practice in the development of road user cost estimates.

[4] The daily road user cost adjusted by 0.25 and also adjusted by a factor of 1.3 to account for operational impacts due to presence of major construction, driver confusion, and general distraction while in the construction zone.

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